

MEMOIRS
OF THE
CARNEGIE MUSEUM.

VOL. IV.

NO. 7.

CATALOG OF FOSSIL FISHES IN THE CARNEGIE MUSEUM.

PART I. FISHES FROM THE UPPER EOCENE OF MONTE BOLCA.

BY CHARLES R. EASTMAN.

INTRODUCTION.

In the summer of 1903, the Carnegie Museum became enriched through the generosity of its founder with a magnificent collection of fossil remains, which, as regards the great group of Vertebrata, is without doubt the largest, most important, and most valuable assemblage ever brought together by a private individual in Europe, and rivals many of the more notable gatherings of fossil vertebrates in the public museums of the world.

This splendid acquisition, long coveted by American and foreign institutions, was the famous Bayet Collection, amassed after years of patient effort and very great expenditure by Baron Ernst de Bayet of Brussels, who for a long time was the Secretary of the late King Leopold of Belgium. A brief summary of the contents of this wonderful collection, a mere *coup d'œil*, as it were, of the riches which it presented at first inspection, was contributed by Dr. W. J. Holland to *Science* for June 19, 1903, and its installation in the Carnegie Museum was duly recorded in the Annual Report of the same institution for that year.¹ Some of the fossil avian remains in the collection were described in the second volume of the Memoirs of the Carnegie Museum, but with the completion of that paper systematic investigation of the great wealth of material contained in the Bayet Collection was temporarily suspended. Recently, however, the present writer was invited to undertake the difficult and important task of classifying and arranging the fossil fishes contained therein, and the present article may be considered as preliminary to more detailed contributions based upon the collection which may be made in the future.

¹ See also J. B. Hatcher; Vertebrate Paleontology at the Carnegie Museum (*Science*, n. s., Vol. XVIII, p. 569).

Some time was spent during the early summer of the year 1910 in making a preliminary survey and general inventory of the collection of fossil fishes as a whole, after which two large suites of specimens were set aside to serve as material for detailed investigation, the results of which will probably be incorporated in special monographs to be published either independently by the Carnegie Museum, or in coöperation with the Museum of Comparative Zoölogy at Cambridge, Massachusetts. One of these suites consists of fishes from the Upper Eocene of Monte Bolca, and the other of fishes from the Upper Jura of Solenhofen. Preliminary to the preparation of more elaborate papers based upon this material, it seemed desirable to Dr. Holland to publish systematic catalogs of the specimens from Monte Bolca and Solenhofen, which would serve the purpose of making known to ichthyologists and others interested in these groups the extent and variety of material which is represented in the Carnegie Museum; and also of placing on record, so as to be immediately available, any special notes, comments, or observations in regard to various specimens which might be found to possess unusual interest, or to elucidate new or imperfectly known features which from the point of view of distribution or otherwise might appear noteworthy.

In response to this suggestion of Dr. Holland, the present Catalog of Upper Eocene Fishes from Monte Bolca has been drawn up, its general plan and arrangement following somewhat closely the admirable model set by Dr. A. S. Woodward in his "*Catalogue of Fossil Fishes in the British Museum*"; due account being taken, however, of recently proposed changes in the classification. In some cases generic and family diagnoses have been amended in the light of fresh discoveries. Also, by way of affording a comparative estimate of the extent of the resources possessed by the Carnegie Museum, the actual number of representatives of various rare species preserved in the British and Carnegie Museums are set down side by side. No invidious comparison is thereby intended, but it seems proper to the writer to call attention to the fact that the western world has acquired through the generosity of Mr. Carnegie a paleontological collection which could not possibly be duplicated except at enormous expenditure of both money and time, and which in some respects rivals at least one of the great collections of the Old World. The student on this side of the Atlantic has therefore at his command unsurpassed facilities for reference and investigation.

The following contribution is a systematic account of the material in the Museum representing the Eocene fishes from Monte Bolca. A similar catalog of the Jurassic fishes from Solenhofen is in preparation. For references to the principal literature dealing with the ichthyic fauna of the Eocene of northern Italy

one may consult a contribution by the present writer published in the Bulletin of the Museum of Comparative Zoölogy for June, 1904 (Vol. XLVI, No. 1). It will be sufficient merely to indicate here the names of the principal contributors to this special literature since the time of Louis Agassiz. These are, in chronological order, Jacob Heckel, Rudolf Kner, Franz Steindachner, Raffaele Molin, Abramo Massalongo, Paolo Liroy, Achille de Zigno, Francesco Bassani, Wladislaw Szajnocha, Carl Gorganovič-Kramberger, Otto Jaekel, A. Smith Woodward, and Rudolf Cramer.

In conclusion it is proper to remark that the writer has taken the liberty of reproducing under each species the references to the literature given by Dr. A. S. Woodward in his Catalogue of the Fossil Fishes in the British Museum, supplementing the same in some cases by citations from more recent papers.

SYSTEMATIC CATALOG.

ELASMOBRANCHII.

Considering the abundance and excellent state of preservation of fossil fishes in the Upper Eocene limestone of Monte Bolca, the relative paucity and lack of variety displayed by cartilaginous forms—sharks and rays—are surprising features. Detached hard parts, such as teeth, dermal fin-spines, and shagreen scales are extremely infrequent, and complete skeletons of *Lamnidae* and other sharks probably are not represented in the museums of the world by more than a dozen specimens. On the other hand, rays are represented by a large number of species and individuals. Of these the commoner form, and at the same time the most exquisitely preserved, is the sting-ray first described by Volta as *Raja muricata* and renamed *Trygon gazzolæ* by Agassiz. The Carnegie Museum is fortunate in having an excellent example of this species, as noted below, and also an admirable cast of *Carcharias (Scoliodon) cuvieri* taken from perhaps the most perfect example yet discovered, the original of which is preserved in Bologna.

The following is a list of all Elasmobranch species at present known to occur in the Eocene fauna of Monte Bolca:

1. *Rhinobatus zignii* (Heckel).
2. *Rhinobatus primævus* Zigno.
3. *Platyrhina bolcensis* (Heckel).
4. *Platyrhina egertoni* Zigno.
5. *Platyrhina gigantea* (Blainville).
6. *Narcine molini* Jaekel.
7. *Trygon muricatus* (Volta).
8. *Trygon zignii* (Molin).

9. *Urolophus crassicaudatus* (Blainville).
10. *Promyliobatis gazolæ* (Zigno).
11. *Lamna vincenti* Winkler.
12. *Odontaspis hopei* Agassiz.
13. *Carcharodon auriculatus* Agassiz.
14. *Pseudogaleus voltai* Jaekel.
15. *Alopiopsis plejodon* Liroy.
16. *Carcharias (Scoliodon) cuvieri* (Agassiz).
17. *Mesiteia emiliæ* Kramberger.

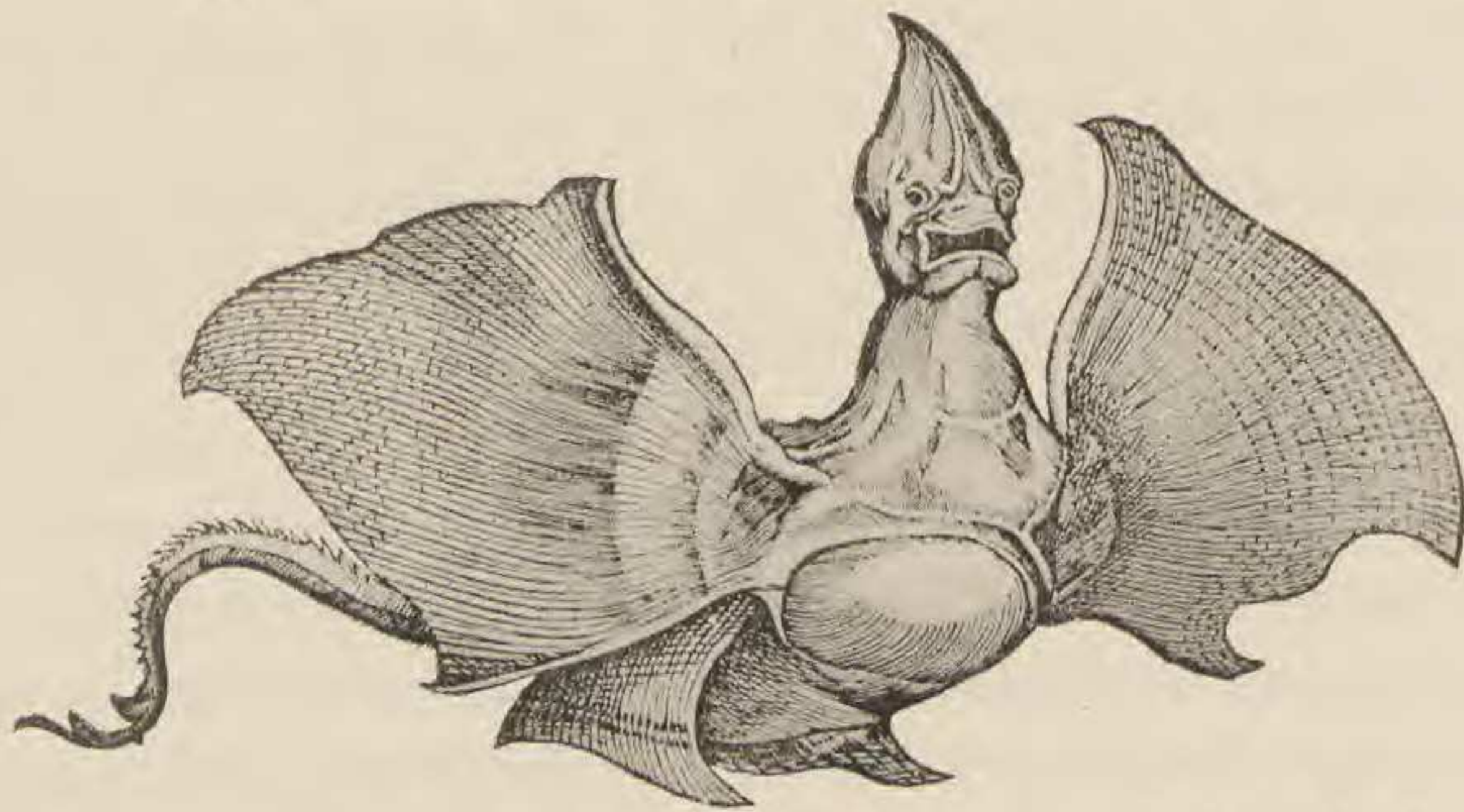


FIG. 1. Figure of a "Sting-ray" prepared and mounted to represent the form of a dragon, as was done by the Italian fishermen in the seventeenth century. Reproduced from the works of Ulysses Aldrovandi, Vol. IV (*De Piscibus*), p. 443. Bologna, 1638.

Family TRYGONIDÆ.

1. *Trygon muricata* (Volta).*

1796. *Raja muricata*, G. S. Volta, Ittiolit. Veronese, p. 37, pl. IX, figs. 1, 2.
1818. *Trygonobatus vulgaris*, H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 336.
1835. *Trygon gazzolæ*, L. Agassiz, Neues Jahrb., p. 297.
1843. *Trygon gazzolæ*, L. Agassiz, Poiss. Foss., Vol. III, p. 382**.
1861. *Alexandrinum*, R. Molin, Sitzungsab. k. k. Akad., Wiss. Wien, Vol. XLII, p. 579.
1874. *Alexandrinum molinii*, A. de Zigno, Mem. R. Istit. Veneto, Vol. XVIII, p. 299, pl. XII.
1874. *Alexandrinum molinii*, A. de Zigno, Catalogo Ragionato dei Pesci Fossili, p. 181.
1874. *Trygon gazo'æ*, A. de Zigno, *op. cit.*, p. 180.

*The Editor has taken the liberty of substituting the feminine form, *muricata*, for the masculine, as the noun *Trygon* is feminine. W. J. H.

1894. *Trygon (Tæniura) muricatus*, O. Jaekel, Die Eocänen Selachier vom Monte Bo'ca, p. 142, pl. IV, fig. 32.
1904. *Trygon muricatus*, C. R. Eastman, Bull. Mus. Comp. Zoöl., Vol. XLVI, p. 23.
1905. *Trygon muricatus*, C. R. Eastman, Mém. Soc. Géol. de France, Vol. XIII, No. 34, p. 8.

The above synonymy is based upon a comparative study of the type specimen and other Eocene rays in the Gazzola Collection, which forms one of the ornaments of the Paris Museum of Natural History. The chief stumbling block which has stood in the way of the recognition and proper characterization of this species has called forth the following remarks from Dr. Otto Jaekel ("Die Eocänen Selachier vom Monte Bolca," 1894): "Es ist auffallend, dass eine Form, die bereits von Volta vortrefflich beschrieben und abgebildet war, und welche durch ihren reich gegliederten Skeletbau so leicht kenntlich ist, so viele nachträgliche Benennungen erfahren hat. Volta kannte und beschrieb das hier, Tafel IV, abgebildete Exemplar der Collection Gazzola; allerdings rechnete er zu der gleichen Art, die er als *Raja muricata* bezeichnete, noch ein mit einem Stachel besetztes Schwanzfragment (*l. c.*, Taf. IX, Fig. 2), welches zu *Urolophus crassicauda* [*sic*] gehört. . . . Zu den späteren Benennungen gab z. Th. die Auffindung neuer Exemplare und die Nichtberücksichtigung des vorher beschriebenen Veranlassung" (p. 142).

This species is represented by a single perfect example, preserved in counterpart (Cat. No. 4521, 4521a) in the Bayet Collection of the Carnegie Museum. It is of rather small size, a little less than 40 cm. in total length, and probably represents an immature individual. The entire anatomy is beautifully displayed, and the caudal spine, which is preserved *in situ*, is of the same configuration as the original of Volta, *op. cit.*, Pl. IX, fig. 2.

CARCHARIIDÆ.

2. *Carcharias (Scoliodon) cuvieri* (Agassiz).

1796. *Squalus carcharias*, G. S. Volta, Ittiolit. Veronese, p. 10, pl. III, fig. 1.
1818. *Carcharias innominatus*, H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 336 (*errore*).
1839. *Galeus cuvieri*, L. Agassiz, Poiss. Foss., Vol. IV, p. 33 (name only).
1860. *Protogaleus cuvieri*, R. Molin, Sitzungsber. k. k. Akad., Wiss. Wien, Vol. XL, p. 583.
1874. *Alopiopsis cuvieri (pars)*, A. de de Zigno, Catalogo Ragionata dei Pesci Fossili, p. 174.

1889. *Protogaleus cuvieri*, A. S. Woodward, Cat. Foss. Fishes Brit. Mus., pt. 1, p. 437.
1894. *Galeus cuvieri*, O. Jaekel, Die Eocänen Selachier vom Monte Bolca, p. 172, text fig. 38.
1904. *Carcharias (Scoliodon) cuvieri*, C. R. Eastman, Bull. Mus. Comp. Zoöl., Vol. XLVI, p. 25, text-figure a.
1905. *Carcharias (Scoliodon) cuvieri*, C. R. Eastman, Mém. Soc. Géol. France, Vol. XIII, No. 34, p. 9, text-figure 1.

The holotype of this species, described in the first instance by Volta, and within recent years by Dr. Otto Jaekel and the present writer, forms part of the Gazzola Collection in the Paris Museum of Natural History. Another specimen, slightly smaller than the type, is preserved in the Museum of the University of Padua, and a third, more complete than either of these two, belongs to the Capellini Museum at the University of Bologna. Exquisite reproductions of this and two other important specimens of fishes from Monte Bolca were presented to the Carnegie Museum in 1909 by Senator Giovanni Capellini.

Fortunately the Bolognese and Parisian specimens supplement each other in several noteworthy respects, for instance as regards the form and position of the

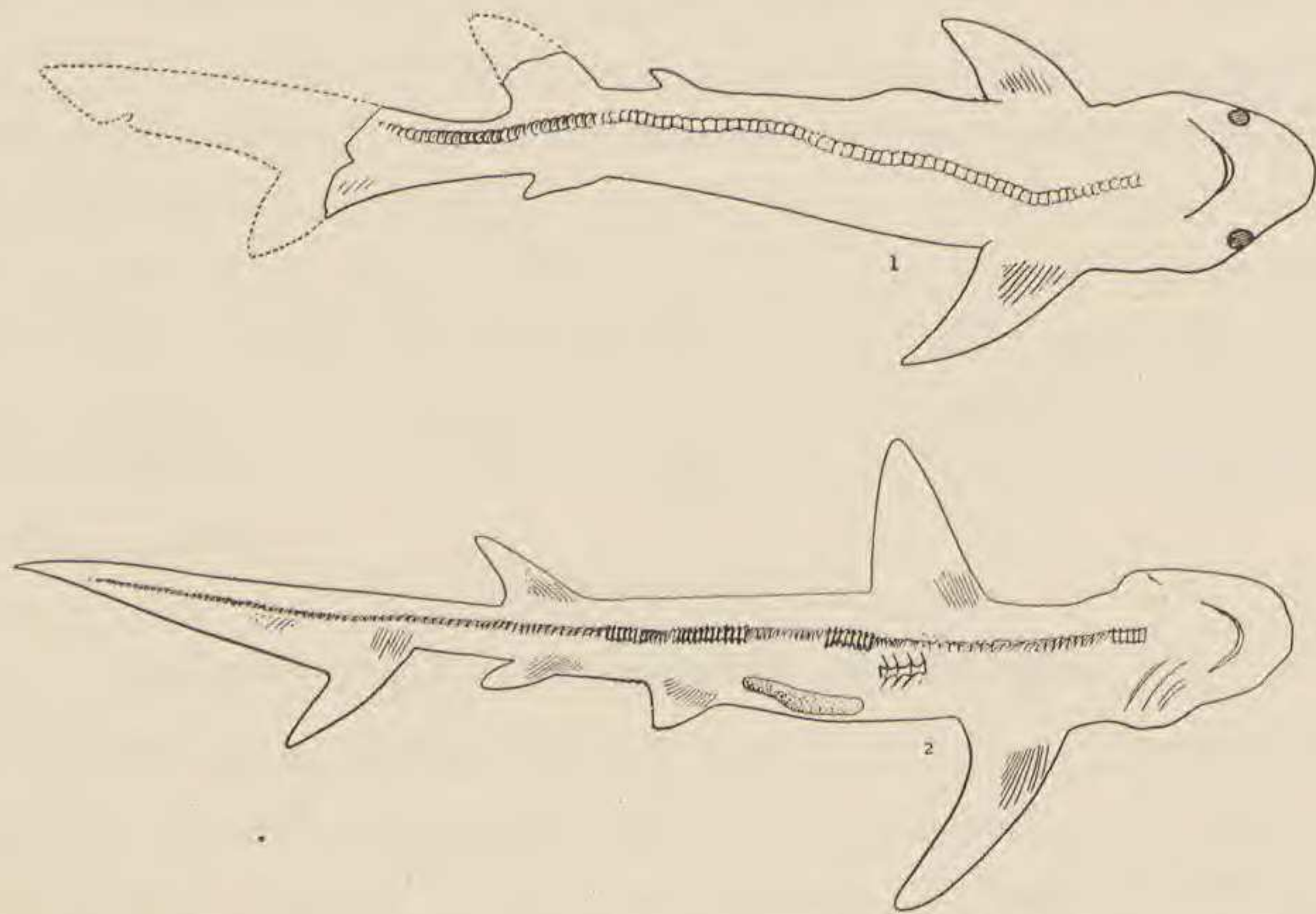


FIG. 2. (1) *Carcharias (Scoliodon) cuvieri* Agassiz. Outline figure of the holotype preserved in the Paris Museum of Natural History. $\times 1/9$. (2) *Carcharias (Scoliodon) cuvieri* Agassiz. Outline figure of the Bolognese example, drawn from the replica in the Carnegie Museum (Cat. No. 4547). $\times 1/9$.

median fins, nature of the shagreen covering, dentition, etc. The anterior dorsal is not shown in the Bolognese example, but as an offset to this the pelvic pair is

well displayed. Both specimens show undigested food and coprolitic matter within the intestinal tract, the course of which latter is clearly indicated.

The accompanying text-figures will show the general configuration of body in the species under consideration, as exemplified by the two individuals just mentioned.

TELEOSTOMI.

Suborder *PROTOSPONDYLI*.

Family *PYCNODONTIDÆ*.

3. *Pycnodus platessus* Blainville.

1796. *Coryphæna apoda*, G. S. Volta, Ittiolit. Veronese, p. 197, pl. XXXV, fig. 1.
 1818. *Zeus platessus*, H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII.
 1833-34. *Pycnodus platessus*, L. Agassiz, Poiss. Foss., Vol. II, pt. 1, p. 185, pl. LXXII, figs. 1, 2 (*non* figs. 3, 4).
 1856. *Pycnodus platessus*, J. J. Heckel, Denkschr. k. k. Akad. Wiss. Wien, math.-naturw. Cl., Vol. XI, pp. 204, 226, pl. VIII, figs. 5, 7.
 1895. *Pycnodus platessus*, A. S. Woodward, Cat. Foss. Fishes Brit. Mus., pt. III, p. 276.
 1905. *Pycnodus apodus*, C. R. Eastman, Mém Soc. Géol. France, Vol. XIII, No. 34, p. 10.

The type is a nearly complete fish contained in the Paris Museum of Natural History.

The specimens representing this species attain on the average a length of about 30 cm. Maximum depth of trunk equalling half the length of the fish exclusive of the caudal fin; head with opercular apparatus occupying about one-quarter of the total length. Teeth of the splenial bone smooth, the outermost indented; the inner or principal series equalling in breadth the two flanking series, of which the inner comprises teeth broader than long, the outer being composed of nearly round teeth. Dorsal fin occupying somewhat less than three-quarters of the total length of the back, arising almost at the highest point.

Of this rare species a single example is preserved in the British Museum; several, in addition to the type, are found in the Paris Museum of Natural History, and one tolerably complete example is preserved in the Carnegie Museum (Cat. No. 4479, 4479a).

4. *Pycnodus gibbus* Agassiz. (Plate XCV, fig. 3.)

1796. *Coryphæna apoda* var., G. S. Volta, Ittiolit. Veronese, p. 147, pl. XXXV, fig. 2.

1796. *Diodon reticulatus*, G. S. Volta, *ibid*, p. 94, pl. XX, fig. 3.
 1844. *Pycnodus gibbus* = *Pycnodus platessus*, L. Agassiz, Poiss. Foss., Vol. II, pt. II, pl. 185, pl. LXXII, figs. 3, 4.
 1856. *Pycnodus gibbosus*, J. J. Heckel, Denkschr. Akad. k. k. Wiss., math.-naturw. Cl., Vol. XI, p. 226, pl. VIII, figs. 3, 4, 6.
 1895. *Pycnodus gibbus*, A. S. Woodward, Cat. Foss. Fishes Brit. Mus., pt. III, p. 276.

The type is a nearly complete fish, the location of which is unknown.

A small species, attaining a length of about 15 cm., maximum depth of trunk slightly exceeding half the total length of the fish (including the caudal fin); head with opercular apparatus occupying somewhat more than one-quarter of the total length. Teeth and fins apparently as in the type species.

Regarded by Agassiz in his final work as the young of *P. pla'essus*, its differential characters were pointed out by Heckel in 1856. Three examples of this form occur among the series of fossil fishes belonging to the Carnegie Museum. They are cataloged under the following numbers: 4480+4480a; 4481; 4482.

Suborder ISOSPONDYLI.

Family CLUPEIDÆ.

Genus CLUPEA (Artedi) Linné.

Three well recognized species of this genus are known from the Upper Eocene of Monte Bolca, and eight others have been named, without, however, having been scientifically defined or illustrated. In addition, at least two generic titles have been proposed for Clupeoid forms from Monte Bolca, the precise status of which is uncertain.² Not improbably some of the smaller types upon which separate species have been founded are to be regarded as the fry of well known larger Clupeoids. In this connection it may be pertinent to quote the following extract from Dr. A. S. Woodward's Catalogue of Fossil Fishes (Part IV, p. 158):

"The following names are also ascribed to supposed Clupeoids from the Upper Eocene of Monte Bolca by P. Liroy (Atti Soc. Ital. Sci. Nat., Vol. viii, 1865, pp. 411-414), but neither the genera nor species are scientifically defined or recognizable: *Clupea ophthalmica*, *C. chrysosoma*, *C. microcephala*, *C. minutissima*, *C. cephalus*, *Uropterina platyrachis*, *Ptericephalina macrogastrina* and *P. elongata*."

The Clupeoids from Monte Bolca which are represented in the collections of

²For instance, an undefined species named *Clupea leptostea* by Agassiz (Neues Jahrbuch, 1835, p. 120) is regarded by P. Liroy as type of a distinct genus, *Ptericephalina*. No illustrations have been published by either of these authors or by subsequent writers of the species thus designated, hence the difficulty of determining whether or not it should rank as an independent genus or species.

the Carnegie Museum are mostly small forms, the greater number of which are referable to the species which was named by Agassiz *Clupea catopterygia*, but the description of which was first published in 1901 by Dr A. S. Woodward. Over a score of Clupeoid species from the same horizon and locality have been described since the time of Agassiz by various authors, many of them in publications not readily accessible; and as the present writer has not yet had an opportunity to consult the original descriptions, nor to study the actual types, except in a few cases, a precise determination of all the specimens in the Bayet Collection has not been attempted. It will suffice for the present to note that the genus *Clupea* is represented in the Carnegie Museum by specimens having the following catalog numbers:

Clupea: Cat. No. 4511 (in counterpart); 4202; 4203; 4204; 4205; 4206; 4219; 4223; 4011; 4012; 4315; 4505; 4506; 4507; 4508; 4509 (in counterpart); 4510.

Suborder *APODES*.

Family *MURÆNIDÆ*.

The extinct species of this family, which appear sparsely in the Upper Cretaceous, and become more abundant in the Eocene, are still imperfectly known. Several anguilliform *types inédits*, designated as such by Professor Louis Agassiz, have recently been described by the present writer from Bolca material preserved in the Paris Museum of Natural History. Some of the undermentioned specimens are remarkable for their fine state of preservation. The name *Leptocephalus* is retained as a convenient designation for the young of various eel-like species.

Genus *EOMYRUS* Storms.

5. ***Eomyrus ventralis*** (Agassiz).

1835. *Anguilla ventralis*, L. Agassiz, Neues Jahrb., p. 307 (name only).
 1839-44. *Anguilla ventralis*, L. Agassiz, Poiss. Foss., Vol. V, pt. 1, p. 15; pt. II, p. 134, pl. XLIII, figs. 2, 3.
 1898. *Anguilla ventralis* (? = *Eomyrus*), R. Storms, Bull. Soc. Be'ge Géol., Vol. X, Mém., p. 240.
 1901. *Eomyrus ventralis*, A. S. Woodward, Cat. Foss. Fishes Brit. Mus., pt. IV, p. 341.

Type.—Nearly complete fish; location unknown; *olim* Hartmann Collection.

This is a rare form, not represented in the collections of the British Museum, and by but a single specimen in the Bayet Collection of the Carnegie Institute, which is cataloged as No. 4017. A specimen of *Clupea* is preserved on the same slab.

6. *Eomyrus latispinus* (Agassiz).

1835. *Anguilla latispina*, L. Agassiz, Neues Jahrb., p. 307 (name only).
 1839-44. *Anguilla latispina*, L. Agassiz, Poiss. Foss., Vol. V, pt. 1, p. 15; pt. II, p. 133, pl. XLIII, fig. 4.
 1901. *Eomyrus latispinus*, A. S. Woodward, Cat. Foss. Fishes Brit. Mus., pt. IV, p. 340.
 1905. *Eomyrus latispinus*, C. R. Eastman, Mém. Soc. Géol. France, Vol. XIII, No. 34, p. 15.

Type.—Nearly complete fish; Paris Museum of Natural History. The specimen cataloged as No. 4411 is the solitary example of this species represented in the Bayet Collection. Four specimens are preserved in the British Museum.

7. *Eomyrus formosissimus* Eastman. (Plate XC, fig. 1.)

1796. *Ophidium barbatum*, Volta, Ittiolit. Veronese, p. 157, pl. XXXVIII, fig. 2 (*errore*).
 1835. *Sphagebranchus formosissimus*, L. Agassiz, Neues Jahrb., p. 307 (name only).
 1844. *Sphagebranchus formosissimus*, L. Agassiz, Poiss. Foss., Vol. V, pt. II, p. 138 (name only).
 1905. *Eomyrus formosissimus*, C. R. Eastman, Mém. Soc. Géol. France, Vol. XIII, No. 34, p. 15, pl. IV, fig. 1; pl. V, fig. 1.

Type.—Nearly complete fish; Paris Museum of Natural History.

A single nearly complete example of this species, preserved in counterpart, is included in the Bayet Collection, and compares favorably with the type specimen. It is cataloged as No. 5233+5233a, and one of the halves is shown on the accompanying plate.

LEPTOCEPHALUS.

Most of the following specimens agree closely with the so-called *Leptocephalus gracilis* of Agassiz, which is evidently immature: 4224; 4225; 4231; 4296; 4458; 4524; 4525; 4526; 4527; 4528 (faint impression). Nos. 4524 and 4526 are in counterpart.

Suborder *PERCESOCES*.

Elevated to the rank of a separate order, this group is stated by Mr. C. Tate Regan to be "defined by the presence of a spinous dorsal, the abdominal pelvic fins each formed of a spine and five branched rays, and the absence of peculiarities of related groups." The same author also remarks:³ "The supposed relationship

³Notes on the Classification of Teleostean Fishes. Proc. Seventh Zool. Congress, Boston Meeting. Cambridge, 1910.

of the Scombroideæ to the Atherinidæ is based on a number of resemblances which do not in my opinion indicate affinity. The Percosoces are more specialized than the Scombroideæ in that spinous fin-rays are developed, and features in which the Atherinidæ approximate to the Scombroideæ appear to have been evolved within the order Percosoces rather than to be those of the prototype of the group."

Family ATHERINIDÆ (Silversides).

Genus RHAMPHOGNATHUS Agassiz.

This genus, which is identical with *Mesogaster* Agassiz, is with difficulty distinguished from various existing Atherinine genera, such as *Chirostoma*, *Menidia*, and *Atherinoides*. The modern forms are mostly marine and of small size.

8. **Rhamphognathus paralepoides** Agassiz.

1796. *Esox sphyraena*, G. S. Volta, Ittiolit. Veronese, p. 107, pl. XXIV, fig. 2 (errore).
 1796. *Esox saurus*, G. S. Volta, *ibid.*, p. 206, pl. I, fig. 2 (errore).
 1796. *Ammodytes tobianus*, G. S. Volta, *ibid.*, p. 220, pl. LIII, fig. 3 (errore).
 1818. *Ammodytes tobianus*, H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 360.
 1835. *Rhamphognathus paralepoides*, L. Agassiz, Neues Jahrb., p. 292 (name only).
 1839-44. *Rhamphognathus paralepoides*, L. Agassiz, Poiss. Foss., Vol. V, pt. I, p. 104, pl. XXXVIII, fig. 1 (*R. pompilius* on plate).
 1876. *Rhamphognathus paralepoides*, F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 186.
 1898. *Rhamphognathus paralepoides*, F. Bassani, Palæont. Italica, Vol. III, p. 81, pl. IX, fig. 3.

Type.—Imperfect fish; Paris Museum of Natural History.

This species is not represented in the British Museum. One fine example in counterpart is preserved in the Bayet Collection, cataloged as No. 5241, 5241a. It has a total length of 19 cm. and has all the fins intact.

Family SPHYRÆNIDÆ (Barracudas).

Genus SPHYRÆNA (Artedi) Bloch and Schneider.

A figure of the skeleton of *Sphyraena* is given by Agassiz in Vol. 5, pl. F, of his *Poissons Fossiles*.

9. **Sphyraena bolcensis** Agassiz.

1796. *Esox sphyraena*, G. S. Volta, Ittiolit. Veronese, p. 107, pl. XXIV, fig. 1.
 1796. *Perca punctata*, G. S. Volta, *ibid.*, p. 208, pl. LI, fig. 1 (errore).

1796. *Esox lucius*, G. S. Volta, *ibid.*, p. 253, pl. LXII (*errore*).
 1818. *Esox spret*, H. D. de Blainville, *Nouv. Dict. d'Hist. Nat.*, Vol. XXVII, p. 341 (*errore*).
 1835. *Sphyræna bolcensis*, L. Agassiz, *Neues Jahrb.*, pp. 292, 294, 305.
 1835. *Sphyræna gracilis* and *maxima*, L. Agassiz, *ibid.*, p. 305.
 1843-44. *Sphyræna bolcensis*, L. Agassiz, *Poiss. Foss.*, Vol. V, pt. 1, p. 95, pl. X, fig. 2.
 1843-44. *Sphyræna gracilis*, L. Agassiz, *ibid.*, p. 96, pl. X, fig. 1.
 1844. *Sphyræna maxima*, L. Agassiz, *ibid.*, p. 97 (name only).
 1876. *Sphyræna bolcensis*, F. Bassani, *Atti. Soc. Veneto-Trent. Sci. Nat.*, Vol. III, p. 185.
 1891. *Sphyræna bolcensis*, A. S. Woodward, *Brit. Mus. Cat. Foss. Fishes*.

Type.—Imperfect fish; Paleontological Museum, Munich.

Six examples of this species are preserved in the British Museum, four in the Bayet Collection of the Carnegie Museum, one of which is in counterpart. These are cataloged as Nos. 4007, 4314, 4357, and 4357*a*, 5240. In No. 4357 the vertebral column is displayed to advantage and seen to consist of twenty-one centra.

Suborder THORACOSTEI.

Under this head Swinnerton,⁴ following Smith Woodward's suggestion, has proposed to unite the Lophobranchs of Cuvier with the Hemibranchs of Cope. As remarked by Boulenger in the volume on fishes in the Cambridge Natural History, "the structure of the Lophobranchs (*Solenostomidæ* and *Lyngnathidæ*) shows that these fishes are only extremely specialized forms of the group of which the Sticklebacks are the well known type, and the character of the 'tufted' gills alone is surely not of sufficiently great importance to warrant the retention of the Lophobranchii as a division equivalent to the suborders adopted in the present classification."

The diagnostic character of this group, which, according to Mr. Regan, may be related to the *Scombresocidæ*, is the presence of a large dermal plate on each side, which in the adult is coössified with the coracoid and anteriorly united by suture to the clavicle. There are two well-marked divisions, the *Gasteroidei* and *Aulostomatoidei*.

Family FISTULARIIDÆ (Cornet Fishes).

Aulostoma, by some regarded as type of a distinct family, *Fistularia* ("Trumpet Fish" or "Flute-mouth" of recent faunas) and *Urosphen* are the only known repre-

⁴*Quart. Journ. Micr. Soc.*, 1902, Vol. XLV, p. 503.

sentatives of this family in the Bolca Eocene. Dr. A. S. Woodward gives the following tabulation of differential characters in these genera:

SYNOPSIS OF GENERA.

No free dorsal spines; caudal fin forked, with elongated median rays; no scales *Fistularia*.
 A series of free dorsal spines; caudal fin rhombic, without elongated ray; small
 ctenoid scales present..... *Aulostoma*.
 Imperfectly known, but all caudal fin-rays much elongated; no scales..... *Urosphen*.

Of the above-mentioned genera, only one imperfect example of *Aulostoma* is preserved in the British Museum. The Carnegie Museum possesses two good examples of *Urosphen*, but none of *Aulostoma* or *Fistularia*. A figure of the existing *F. tabaccaria*, which sometimes attains a length of six feet, is given by Agassiz in his *Poissons Fossiles*, Vol. IV, pl. 35, fig. 1 (wrongly labelled *Aulostoma chinensis*).

Genus UROSPHEN Agassiz.

10. **Urosphen dubia** (Blainville). (Plate XC, fig. 2; Plate XCVI, fig. 2.)
 1796. *Fistularia tabaccaria*, G. S. Volta, Ittiolit. Veronese, p. 130, pl. XXIX, fig. 4
 (errore).
 1818. *Fistularia dubia*, Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 341.
 1839-42. *Urosphen fistularis*, L. Agassiz, Poiss. Foss., Vol. IV, p. 284, pl. XXXV,
 fig. 6 (name only).
 1874. *Urosphen fistularis*, A. de Zigno, Catalogo Ragionato dei Pesci Fossili,
 p. 107.
 1876. *Urosphen fistularis*, F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III,
 p. 182.
 1905. *Urosphen dubia*, C. R. Eastman, Mém. Soc. Géol. de France, Vol. XIII,
 No. 34, p. 20.

Type.—Imperfect fish; Paris Museum of Natural History.

This, the type species, attains a length of about 45 cm., of which the elongated caudal fin forms one-fourth. The dorsal and anal fins are similar and opposite, and in the smaller of the two under-mentioned specimens eighteen rays are to be counted in each.

4015, 4015a. Imperfect specimen, in counterpart, in which the head has a length of 13 cm., and the trunk is preserved to a point a little behind the median fins. Illustrated in Plate XC, fig. 2.

4499. Small, excellently preserved example, in which the unpaired fins are well displayed. Shown in Plate XCVI, fig. 2.

Suborder *SOLENICHTHYES*.

This group is apparently related to the preceding (Thoracostei), but differs from it in that on each side a series of plates takes the place of the single dermal plate of the latter. There are two families, the *Centriscidæ* and *Amphisilidæ*.

Family CENTRISCIDÆ.

Centriscus, with five species in the Atlantic and Pacific Oceans, represents the family at the present day. Isolated spines from the Pliocene of Tuscany have been referred to the same genus. *Rhamphosus*, from the Upper Eocene of Monte Bolca, is believed to have been allied to *Centriscus*.

Genus RHAMPHOSUS Agassiz.

11. *Rhamphosus aculeatus* (Blainville).

1796. *Uranoscopus rastrum*, G. S. Volta, Ittiolit. Veronese, p. 22, pl. V, fig. 4.
 1796. *Centriscus*, G. S. Volta, *ibid.*, pl. LXXV, fig. 1 (*errore*).
 1818. *Centriscus aculeatus*, H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVIII, p. 339.
 1835. *Rhamphosus aculeatus*, L. Agassiz, Neues Jahrb., p. 291 (name only).
 1839-42. *Rhamphosus aculeatus*, L. Agassiz, Poiss. Foss., Vol. IV, p. 270, pl. XXII, fig. 7.
 1888. *Rhamphosus aculeatus*, L. Vaillant, Expéd. Scient. Travailleur et Talisman—Poissons, p. 339.
 1898. *Rhamphosus aculeatus*, F. Bassani, Palæontogr. Italica, Vol. III, p. 82, pl. IX, fig. 4.
 1901. *Rhamphosus aculeatus*, A. S. Woodward, Cat. Fossil Fishes Brit. Mus., Part IV, p. 377.

Type.—Imperfect fish, Paris Museum of Natural History.

This species is represented in the British Museum collections by a single imperfect specimen, and in the Carnegie Museum by a complete head, including the attenuated and elongated snout, of a rather small-sized example. (Cat. No. 4213.)

Suborder ACANTHOPTERYGII.

This large and well characterized suborder, the most comprehensive of the whole class of Pisces, is commonly understood as embracing the *Berycidæ* and allied families, together with the *Perciformes*, *Scombriformes*, *Kurtiformes*, *Jugulares*, *Gobiiformes*, etc., of Boulenger. The removal of the berycoid fishes to form

separate assemblages has recently been proposed by Mr. Regan,⁵ whose reasons for this procedure are thus stated:

"It is usually recognized that the berycoid fishes are very generalized, as is shown by the large number of rays in the pelvic fins, the persistence of the pneumatic duct in certain genera, and the abundance of the group in Cretaceous times. . . . In the Holocentridæ and Berycidæ the attachment [of the pelvic bones to the clavicles] is by ligament, and in the Polymixiidæ the pelvic bones are quite remote from the clavicles; in the last-named the outermost ray of the pelvic fin, although simple, is not spinous, but articulated. In many species of *Myripristis* the distal part of the maxillary enters the gape when the mouth is widely opened and bears a series of true teeth which are set in sockets. . . . These facts lead me to believe that the resemblance of the Cretaceous Clupeoids, *Ctenothrissa* and *Pseudoberyx*, to the berycoids may be due to their real affinity, and that they may have belonged to the group from which the berycoid fishes have evolved."

Division A. BERYCIFORMES.

(Order *Berycomorphi* Regan.)

In this division the pelvic fins are thoracic, usually with more than five articulated rays in addition to the spine. No bony stay between the circum-orbital ring and preoperculum.

Family BERYCIDÆ.

This family, in the language of Boulenger, "is remarkable for the retention of two archaic characters: the large number of rays in the ventral fins, and the duct between the air-bladder and the digestive tract; the latter character is, however, not universal, and has only been found in two genera (*Beryx* and *Holocentrum*). The scaling of the body varies greatly, and so does the development of the spines in the vertical fins."

The *Berycidæ* were abundantly represented in Cretaceous times by *Beryx* and other genera more or less closely related to living forms, and they appear to have been the precursors of the Perciform fishes. About seventy species, referred to thirteen genera, are known to live at the present day, mostly at great depths, in the seas nearly all over the world.

Genus MYRIPRISTIS Cuvier.

A figure of the skull of this genus, and one of the skeleton of *Holocentrum*, are given by Agassiz in Vol. IV, plate B, of his *Poissons Fossiles*.

⁵ Advance Print from Proc. Seventh International Zool. Congress, Boston Meeting, 1910, p. 12.

12. *Myripristis leptacantha** Agassiz.

1796. *Perca formosa*, G. S. Volta, Ittiolit. Veronese, p. LXXX, pl. XVII, fig. 2 (*errore*).
1818. "*Perca formosa*," H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 347.
- 1838-39. *Myripristis leptacanthus*, L. Agassiz, Poiss. Foss., Vol. IV, pp. 5, 111, pl. XV, fig. 4.
1876. *Myripristis leptacanthus*, F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 176.
1901. *Myripristis leptacanthus*, A. S. Woodward, Brit. Mus. Cat. Foss. Fishes, Pt. IV, p. 410.

Type.—Imperfect fish; Paleontological Museum, Munich.

This species is represented in the collection of the Carnegie Museum by a number of well preserved examples, cataloged as follows: 4209, 4216, 4338, 4435, 4446, 4495, 4496, 4497.

Genus HOLOCENTRUM (Artedi) Cuvier.

13. *Holocentrum macrocephalum* Blainville. (Pl. XCII, fig. 1.)

1796. *Holocentrus sogo*, G. S. Volta, Ittiolit. Veronese, p. 210, pl. LI, fig. 2 (*errore*).
1796. *Chaetodon saxatilis*, G. S. Volta, *ibid.*, p. 265, pl. LXIV, fig. 1 (*errore*).
1796. *Chaetodon*, G. S. Volta, *ibid.*, pl. LXXII, fig. 1 (*errore*).
1818. *Holocentrus macrocephalus*, H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 349.
1818. *Chaetodon saxatilis*, H. D. de Blainville, *ibid.*, p. 353 (*errore*).
- 1834-36. *Holocentrum pygæum* L. Agassiz, Poiss. Foss., Vol. IV, pp. 6, 107, pl. XIV.
1901. *Holocentrum macrocephalum*, A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, Part IV, p. 413.

Type.—Imperfect fish; Paris Museum of Natural History.

Several fine large specimens, as perfect as any hitherto reported, besides a number of smaller ones, form part of the Bayet Collection in the Carnegie Museum. A typical example is represented in Plate XCII, fig. 1. The series is cataloged under the following numbers: 4368, 4370, 4372, 4437, 4444, 4445, 4455, 4494, 4495, 4502. The original of Plate XCII, fig. 1, is cataloged as No. 4455.

Division B. SCOMBRIFORMES.

As remarked by Boulenger, the series of families that cluster round the mackerel offer so many modifications of structure that it is impossible to draw up a diagnosis

*The noun *Myripristis* being feminine, the specific name should agree with it. *Editor*.

differentiating every one of its members from the *Perciformes*, with which they are closely connected, and from which they hardly deserve to be separated. The geological range of this division is from the Lower Eocene to the present day.

Family CARANGIDÆ (Pompanos, etc.).

Genus SEMIOPHORUS Agassiz.

14. **Semiophorus velifer** (Volta). (Plate XCVI, fig. 1.)

1796. *Kurtus velifer*, G. S. Volta, Ittiolit. Veronese, p. XXVII, pl. VII, figs. 1, 2 (non fig. 3).
 1818. *Chaetodon velifer*, H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 355.
 1835. *Semiophorus velifer*, L. Agassiz, Neues Jahrb., p. 301 (name only).
 1838-42. *Semiophorus velifer*, L. Agassiz, Poiss. Foss., Vol. IV, pp. 14, 219, pl. XXXVIIa.
 1859. *Semiophorus velifer*, A. G. Massalongo, Specimen Photogr. Anim. Foss. Agr. Veron., p. 27, pl. VI.
 1876. *Semiophorus velifer*, F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 179.
 (?) 1878. *Semiophorus gigas*, A. de Zigno, Mem. R. Instit. Veneto, Vol. XX, p. 488, pl. XV.
 1901. *Semiophorus velifer* (Volta), Brit. Mus. Cat. Fossil Fishes, Part IV, p. 430.
Type.—Nearly complete fish; Paris Museum of Natural History.

One fine specimen and two imperfect ones, partially restored, are preserved in the British Museum of Natural History. Two excellent examples, one of them a hypotype, having been figured by Massalongo, are contained in the Bayet Collection of the Carnegie Museum. An illustration is given of the original of Massalongo's figure in the accompanying plate. This bears the catalog No. 4467, and the second specimen that of No. 4466.

Genus PLATAX Cuvier.

15. **Platax subvespertilio** (Blainville).

This large and handsome species is not represented in the British Museum. The type and several other specimens are preserved in the Paris Museum of Natural History, others at Verona and elsewhere in Italy. A cast of an extraordinarily perfect example belonging to the University of Bologna (*olim* Zigno Coll.) was presented to the Carnegie Museum a few years ago through Senator G. Cappellini,

together with casts of *Carcharias* (= *Scoliodon*) and *Seriola*. This bears the catalog number of 4549.

Genus *VOMEROPSIS* Heckel.

16. ***Vomeropsis longispinus*** (Agassiz). (Plate XCIII, figs. 1, 2.)
 1796. *Zeus vomer*, G. S. Volta, Ittiolit. Veronese, pl. XXXV, fig. 3 (*errore*).
 1796. *Zeus triurus*, G. S. Volta, *ibid.*, p. 181, pl. XLIV, fig. 2 (*errore*).
 1836-44. *Vomer longispinus*, L. Agassiz, Poiss. Foss., Vol. V, Pt. I, pp. 4, 28, pls. V, VI.
 1854. *Vomeropsis longispinus*, J. J. Heckel, Sitzungsab. Akad. Wiss., math.-naturw. Cl., Vol. XI, p. 135.
 1901. *Vomeropsis longispinus*, A. S. Woodward, Brit. Mus. Cat. Foss. Fishes, pt. IV, p. 436.

Type.—Imperfect, partly distorted fish; Paris Museum of Natural History. One fine small specimen, and a larger imperfect one, are preserved in the British Museum. Two large, nearly complete examples belong to the Carnegie Museum, and are cataloged as numbers 4350 and 4489. These are shown of the natural size in the plate.

Genus *MENE* Lacépède.

This genus, represented in the existing fauna by a single East Indian species, and by two in the Eocene of Monte Bolca, has recently been studied in considerable detail by Dr. Rudolf Cramer (*Zeitschr. deutsch. geol. Gesell.*, Jahrgang 1906, Band 58, pp. 181-212.) The accompanying diagram of the cranial osteology is reproduced from a figure given by this author.

17. ***Mene rhombea**** (Volta). (Text-figure 3.)

1796. *Scomber rhombeus* G. S. Volta, Ittiolit. Veronese, p. 184, pl. XVIII.
 1818. *Zeus rhombeus* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 356.
 1833. *Gasteronemus rhombeus* L. Agassiz, Poiss. Foss., Vol. V, pt. I, p. 20, pl. II.
 1901. *Mene rhombeus* A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, pt. IV, p. 439.
 1906. *Mene rhombeus* Rudolf Cramer, *Zeitschr. deutsch. geol. Ges.*, vol. 58, p. 181, pl. X.

Type.—Nearly complete fish; Paleontological Museum, Munich.

Numerous fine examples of this species are preserved in the Carnegie Museum, the whole forming an excellent series for study. They are cataloged under the following numbers: 4009, 4010, 4344, 4349 (+4349a), 4353, 4365, 4310, 4369

* *Μήνη* nom. fem. ∴ *rhombea*. *Editor*.

(+4369a), 4483, 4484, 4485, 4486, 4487, 4488 (+4488a), 4493, 4490, 4491, 5235, 5236.

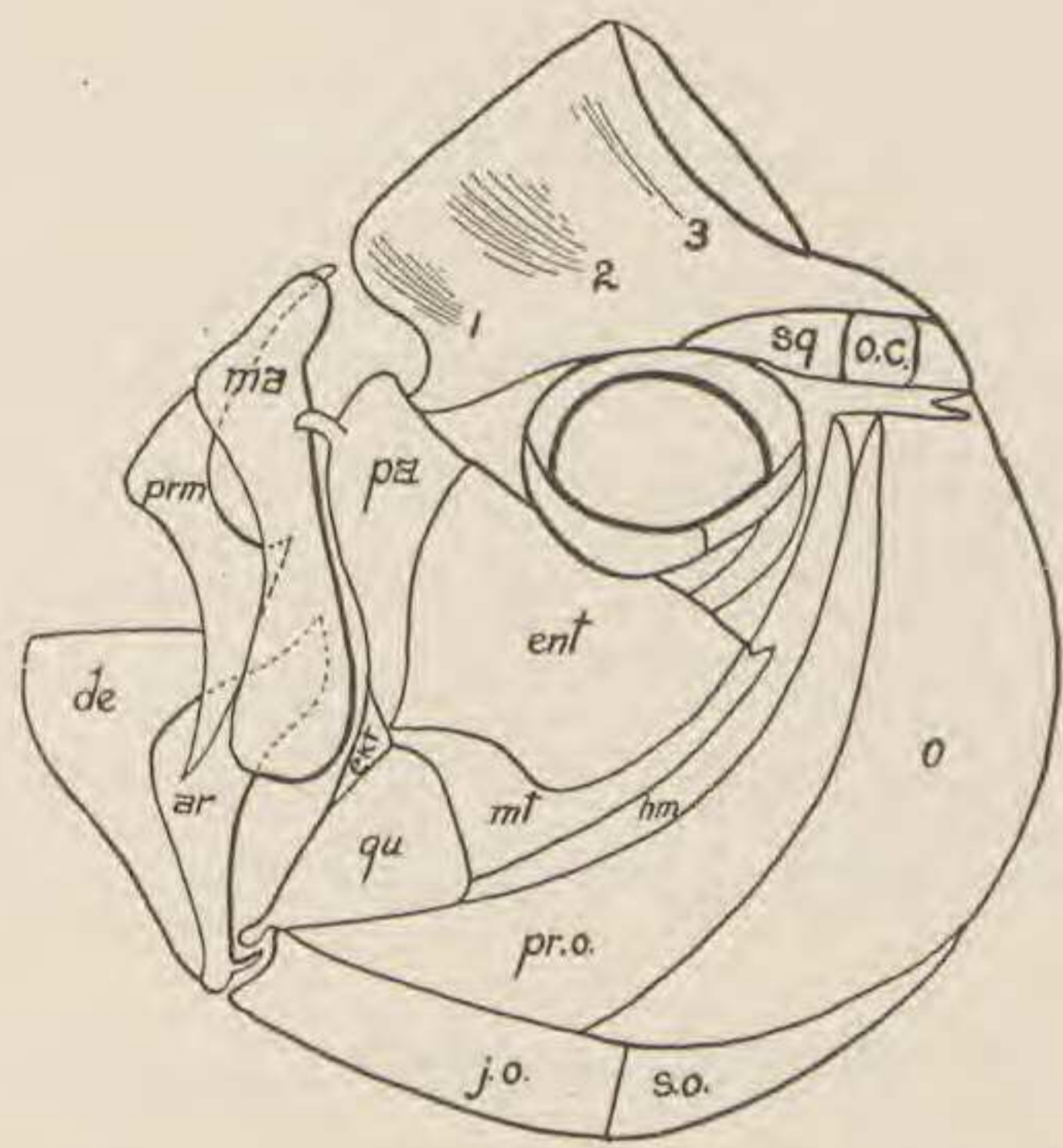


FIG. 3. *Mene rhombea* Volta. Restoration of head portion, showing cranial osteology, about one-half natural size (after Cramer). *ar*, articular; *de*, dentary; *ect*, ectopterygoid; *ent*, entopterygoid; *hm*, hyomandibular; *j.o.*, interoperculum; *ma*, maxilla; *mt*, metapterygoid; *o*, operculum; *pa*, palatine; *prm*, premaxilla; *pr.o*, preoperculum; *qu*, quadrate; *s.o.*, suboperculum; *sq*, squamosal; 1, 2, 3, the three centers of ossification visible in the cranial roof.

18. ***Mene oblonga**** (Agassiz). (Plate XCII, fig. 3.)

This species is much rarer than the one immediately preceding. Two examples of it are reported as belonging to the British Museum, and four are now the property of the Carnegie Museum. These are catalogued as follows: 4333, 4337, 4492, 4020. The last mentioned specimen is shown of the natural size in Plate XCII, fig. 3.

Genus **SERIOLA** Cuvier.

Differs from *Caranx* in having the pectoral fins relatively small, anal shorter than the posterior dorsal, and no enlarged or thickened scales along the lateral line.

19. ***Seriola prisca*** (Agassiz). (Plates XCVII, fig. 6; XCVIII, fig. 1; XCIX, fig. 3; CI, fig. 2.)

1796. *Scomber pelagicus* G. S. Volta, Ittiolit. Veronese, p. 74, pl. XVI (errore).
 1796. *Coryphaena* G. S. Volta, *ibid.*, pl. LXVIII (errore).
 1818. *Scomber pelagicus*? H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 346.
 1835. *Lichia prisca* L. Agassiz, Neues Jahrb., p. 292 (name only).
 1834-44. *Lichia prisca* L. Agassiz, Poiss. Foss., Vol. V, pt. I, p. 34, pls. XI, XIa.
 1854. *Seriola prisca* J. J. Heckel, Sitzungsber. k. Akad. Wiss., math.-naturw. Cl., Vol. XI, p. 136.

* See editorial note at foot of p. 166.

1876. *Lichia prisca* F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 184.
 1901. *Seriola prisca* A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, pt. IV, p. 444.

Type.—Nearly complete fish; Paleontological Museum, Munich.

Numerous fine large specimens of this species are contained in the Bayet Collection of the Carnegie Museum, some of them exquisitely preserved, a few somewhat distorted. A replica of an unusually large individual, *olim* collection Baron de Zigno, now in the Capellini Museum of the University of Bologna, was presented to the Museum in 1909 through the courtesy of Senator Giovanni Capellini. It has a total length to base of the caudal fin of 25 inches (= 62.5 cm.) and is cataloged as number 4548. The remaining examples bear the following departmental numbers: 4230 (*juv.*), 4545, 4006, 4018, 4295, 4364+4364a, 4373, 4413, 4469, 4410.

20. *Seriola analis* (Agassiz).

1796. *Scomber* G. S. Volta, Ittiolit. Veronese, pl. LXIX, fig. 1 (*errore*).
 1796. *Polynemus* G. S. Volta, *ibid.*, pl. LXXV, fig. 3 (*errore*).
 1835. *Carangopsis analis* L. Agassiz, Neues Jahrb., p. 304 (name only).
 1843-44. *Carangopsis analis* L. Agassiz, Poiss. Foss., Vol. V, pt. I, p. 42, pl. IX, fig. 1.
 1848. *Lichia analis* C. G. Giebel, Fauna d. Vorwelt, Fische, p. 76.
 1901. *Seriola analis* A. S. Woodward, Brit. Mus. Cat. Fossil Fishes pt. IV, p. 445.

Type.—Imperfect fish; Paleontological Museum, Munich.

This is a comparatively small and slender species, much rarer than the preceding. The anal fin is slightly longer than in the type, apparently with twenty-two articulated rays. Three examples are preserved in the British, and a like number in the Carnegie Museum, the latter cataloged as follows: 4003 (in counterpart); 4330, 4351 (also in counterpart).

Genus CARANGOPSIS Agassiz.

This genus differs from *Caranx* in having larger teeth, no enlarged or thickened scales along the lateral line, and fin shorter than the posterior dorsal, and anal fin-spines insignificant, not separate from the fin.

21. *Carangopsis brevis* (Blainville).

1796. *Polynemus quinquarius* G. S. Volta, Ittiolit. Veronese, p. 153, pl. XXXVI (*errore*).
 1818. *Mugil brevis* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 344.

1835. *Carangopsis latior* L. Agassiz, Neues Jahrb., p. 293 (name only).
 1843-44. *Carangopsis latior* L. Agassiz, Poiss. Foss., Vol. V, pt. 1, p. 40, pl. IX, fig. 2.
 1876. *Carangopsis latior* F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 185.
 1901. *Carangopsis brevis* A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, pt. IV, p. 446.

Type.—Imperfect distorted fish; Paris Museum of Natural History.

This species is represented by a single example in the Bayet Collection, cataloged as No. 4371. It is very well preserved, and bears an original label which reads "*Carangopsis latior*," hand-writing unknown.

22. **Carangopsis dorsalis** Agassiz. (Plate XCI, fig. 2.)

1796. *Sciæna undecimalis* G. S. Volta, Ittiolit. Veronese, p. 217, pl. LIII, fig. 1 (errore).
 1818. *Sciæna undecimalis*? H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 348.
 1835. *Carangopsis dorsalis* L. Agassiz, Neues Jahrb., p. 304 (name only).
 1834-44. *Carangopsis dorsalis* L. Agassiz, Poiss. Foss., Vol. V, pt. 1, p. 41, pl. VIII.
 1901. *Carangopsis dorsalis* A. S. Woodward, Cat. Fossil Fishes British Museum, pt. IV, p. 447.

Type.—Imperfect fish; Paris Museum of Natural History.

Trunk somewhat less deep than in the type species, and anal fin with fourteen or fifteen articulated rays.

Six good specimens of this form are contained in the Bayet Collection of the Carnegie Museum, one of which, superior in point of preservation, is shown in the accompanying plate. The series is cataloged as follows: 4361, 4359, 4359a, 4345, 4530, 4530a, 4531, 4531a, 4537, 4537a.

Genus DUCTOR Agassiz.

23. **Ductor leptosomus** Agassiz.

1796. *Callionymus vestenæ* G. S. Volta, Ittiolit. Veronese, p. 140, pl. XXXII, fig. 2 (errore).
 1796. *Gobius smyrnensis* G. S. Volta, *ibid.*, p. 241, pl. LVIII, fig. 2 (errore).
 1818. "*Callionymus vestenæ*" H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 359.
 1818. "*Gobius smyrnensis*" H. D. de Blainville, *ibid.*, p. 358.

1834. *Ductor leptosomus* L. Agassiz, Verhandl. Ges. Vaterland. Mus. Böhmen, p. 66 (name only).
 1835. *Ductor leptosomus* L. Agassiz, Neues Jahrb., p. 293 (name only).
 1834-44. *Ductor leptosomus* L. Agassiz, Poiss. Foss., Vol. V, pt. 1, p. 53, pl. XII.
 1876. *Ductor leptosomus* F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 184.
 1901. *Ductor leptosomus* A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, pt. IV, p. 448.

Type.—Imperfect fish; Paris Museum of Natural History.

One large and several smaller and imperfect specimens are to be seen in the British Museum. The Carnegie Museum possesses a series catalogued as follows: 4214, 4220 and 4220a, 4227 (imperfect), 4130, 4513, 4514, 5242, 5243 (*juv.*).

Genus ACANTHONEMUS Agassiz.

This genus, like the preceding, is entirely extinct, and known by a single species from the Upper Eocene and Upper Oligocene respectively, both exceedingly rare.

24. *Acanthonemus subaureus* (Blainville). (Plate XCIV.)

1796. *Zeus gallus* G. S. Volta, Ittiolit. Veronese, p. 87, pl. XIX, fig. 3 (*errore*).
 1796. *Chaetodon aureus* G. S. Volta, *ibid.*, p. 212, pl. LI, fig. 3 (*errore*).
 1818. *Chaetodon subaureus*, H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 354.
 1834. *Acanthonemus filamentosus* L. Agassiz, Poiss. Foss., Vol. V, pt. I, p. 25, pls. III, IV.

Type.—Imperfect fish; Paris Museum of Natural History.

The fine example shown in the accompanying plate, catalogued as No. 4439, is the third example known. The other two, one of which is the type, belong to the Paris Museum. The six anterior dorsal fin-rays are greatly elongated.

Genus TRACHYNOTUS Lacépède.

To this genus, as re-defined by Cuvier from his study of recent forms, a single small species was somewhat doubtfully referred by Agassiz on the basis of a solitary example from the Eocene of Monte Bolca. After quoting Cuvier's remarks on the near approach of this genus to *Lichia* and its allies, Agassiz remarks: "D'après cela, on comprend qu'il doit être plus difficile encore de déterminer les espèces fossiles; surtout si toutes les parties du squelette ne sont pas parfaitement con-

servées. Aussi en rapportant à ce genre l'empreinte fossile que je vais décrire, je me suis laissé guider uniquement par la forme générale du poisson."

Further on, in his description of the holotype of *T. tenuiceps*, the same author observes: "Quoique on ne voit pas la dentition de l'intérieur de la gueule, la forme générale du poisson, les proportions du corps, et cet air de famille si inappréciable en histoire naturelle, compensent ce qu'il y a de défectueux dans les détails, et comme on ne peut balancer qu'entre les genres *Platax* et *Trachinotus*, il ne peut rester aucun doute sur sa position générique dans la famille des Scomberoides."

The above paragraphs are of interest as revealing the mental process, or personal equation on the part of an experienced student of ichthyology, who depended upon instinct, as it were—that is, an acquired second sight or delicacy of perception, or in a word *feeling*—in determining the systematic position of doubtful or of imperfectly preserved fossil remains. Be that as it may, no one has shown cause for removing Agassiz's so-called *Trachinotus tenuiceps* from the position assigned to it, and until the present time the type specimen has remained absolutely unique.

The Carnegie Museum is fortunate in possessing two well preserved examples which may be provisionally referred to the species described by Agassiz, although they greatly exceed the type in size, and one, which has a deeper form of body than Agassiz's original, may be found on further investigation to differ from it sufficiently to warrant the establishment of a separate species. The doubtful specimen last mentioned is illustrated in Plate C.

25. **Trachinotus tenuiceps** Agassiz. (Plate XCI, fig. 1.)

1796. *Chaetodon rhomboides* (errore) G. S. Volta, Ittiolit. Veronese, p. 162, pl. XXXIX, fig. 3.

1835. *Trachinotus tenuiceps* L. Agassiz, Poiss. Foss., Vol. V, pt. I, p. 36, pl. VII.

Type.—Nearly perfect fish in counterpart; Paris Museum of Natural History.

Of the two examples provisionally referred to this species, the larger (Cat. No. 4367) is preserved on a single slab, the other in counterpart (Cat. No. 4532, 4532a). One of the containing slabs of the latter is shown in the accompanying plate. The individual which is not figured has a total length to base of the caudal fin of 16 cm.

GENUS ZANCLUS.

Of this existing genus two fossil species have been described, one from the Eocene of Monte Bolca, the other from the Calcaire Grossier of Paris. No examples of either are found to be in the British Museum, and the undermentioned specimen of *Z. brevirostris* is the only one thus far reported besides the type. A figure of the recent *Z. cornutus* is given by Agassiz, Poiss. Foss., Vol. IV, pl. G, fig. 1.

26. *Zanclus brevirostris* Agassiz. (Plate XCVII, fig. 3.)1796. *Chaetodon canescens* Volta, Ittiolit. Veronese, pl. XXVI, fig. 2 (*errore*).1842. *Zanclus brevirostris* L. Agassiz, Poiss. Foss., Vol. IV, p. 236, pl. XXXVIII.*Type*.—Nearly complete fish; Paris Museum of Natural History.

Represented by a single admirably preserved specimen in the Bayet Collection, cataloged as No. 4415, and bearing an original label which reads as follows: "Dono di Eugenio Sardagno, Venezia 18 Nr. 1888, ex Galleria Manfrin." It is shown of the natural size in Plate XCVII, Fig. 3.

Family SCOMBRIDÆ. Mackerels.

All the existing members of this family are marine, and all known fossil representatives occur in marine deposits. The Tunny, or Horse Mackerel (*Thynnus thynnus* Linn.) is the Tuna or Leaping Tuna of southern California, and is the largest fish of the mackerel family, reaching a length of ten feet or more, and a weight of 1500 pounds. It also occurs in the fossil state in the Pleistocene (Forest Bed Series) of Norfolk, England.

Genus THYNNUS Cuvier.

(Syn. *Orycynus* Cuvier.)27. *Thynnus lanceolatus* (Agassiz).1796. *Scomber alatunga* G. S. Volta, Ittiolit. Veronese, p. 123, pl. XXIX, fig. 1 fig. 1 (*errore*).1796. *Salmo cyprinoides* G. S. Volta, *ibid.*, p. 214, pl. LII.1818. *Clupea cyprinoides* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 343.1818. *Scomber altalunga* H. D. de Blainville, *ibid.*, p. 345 (*errore*).1835. *Orycynus lanceolatus* L. Agassiz, Neues Jahrb., p. 293.1835-44. *Orycynus lanceolatus* L. Agassiz, Poiss. Foss., Vol. V, pt. 1, p. 59, pl. XXIII.1876. *Orycynus lanceolatus* F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 183.1889. *Thynnus lanceolatus* R. Storms, Bull. Soc. Belge Géol., Vol. III, Mém., p. 178.1901. *Thynnus lanceolatus* A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, pt. IV, p. 456.*Type*.—Imperfect fish; Paris Museum of Natural History.

This comparatively small species is represented by a single imperfect fish 22

cm. in length, partly distorted, in the British Museum of Natural History, and by two larger specimens measuring in total length 33 and 38 cm. respectively, in the Carnegie Museum. These are cataloged under the numbers 4223+4223a, and 4890. There is also a distorted and imperfectly restored specimen cataloged as No. 4363, which may possibly be referred to this species.

28. **Thynnus latior** (Agassiz).

1796. *Scomber orycynus* Volta, Ittiolit. Veronese, p. 226, pl. LV, fig. 2 (*errore*).

1844. *Orycynus latior* Agassiz, Poiss. Foss., Vol. V, p. 60, pl. XXIV.

Type.—Imperfect fish; Paris Museum of Natural History.

The type specimen of this form has remained up to the present time unique. One nearly complete individual, preserved in counterpart, belongs to the Bayet Collection, and is cataloged as No. 4533, 4533a. All of the fins are beautifully displayed.

29. **Thynnus bolcensis** Agassiz.

1796. *Scomber thynnus* Volta, Ittiolit. Veronese, p. 119, pl. XXVII (*errore*).

1844. *Thynnus bolcensis* Agassiz, Poiss. Foss., Vol. V, pt. 1, p. 57 (undescribed).

Type.—Imperfect fish. Paris Museum of Natural History.

The type and, until recently, solitary known example of this species was wrongly identified with the existing Tunny by Volta, and afterwards recognized by Agassiz as belonging to a distinct species, for which he proposed the undefined name of *Thynnus bolcensis*. A fine large example measuring 95 cm. in total length, and displaying the essential features to good advantage, forms one of the ornaments of the Bayet Collection. It is on exhibition in the Hall of Fossil Vertebrates, and is catalogued as No. 5245. A more detailed account of this form is reserved for a subsequent paper.

Genus AUXIS Cuvier.

This genus resembles *Scomber* proper in having the two dorsal fins well separated, but the caudal pedicle carries a lateral keel and the pectoral scales are enlarged. The following species is doubtfully referred to this genus by A. Smith Woodward.

30. **Auxis (?) propterygia** (Agassiz).

1796. *Scomber pelamis* G. S. Volta, Ittiolit. Veronese, p. 66, pl. XIV, fig. 2 (*errore*).

1796. *Scomber trachurus* G. S. Volta, *ibid.*, p. 125, pl. XXIX, fig. 2 (*errore*).

1796. *Ophicephalus striatus* G. S. Volta, *ibid.*, p. 193, pl. XLVIII, fig. 1 (*errore*).

1818. *Scomber pelamis* (?) H. D. de Blainville, *Nouv. Dict. d'Hist. Nat.*, Vol. XXVII, p. 345.

1818. *Scomber trachurus* H. D. de Blainville, *ibid.*, p. 345.
 1818. *Labrus bifasciatus* ("? one of the species of *Scomber*"), H. D. de Blainville, *ibid.*, p. 351.
 1835. *Thynnus propterygius* L. Agassiz, Neues Jahrb., p. 292 (name only).
 1835-44. *Thynnus propterygius* L. Agassiz, Poiss. Foss., Vol. V, Pt. 1, p. 55, pl. XXVII.
 1876. *Thynnus propterygius* F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 183.
 1882. *Thynnus propterygius* (? = *Auxis*), D. G. Kramberger, Beitr. Paläont. Oesterr.-Ungarns, Vol. II, p. 118.
 1901. *Auxis* (?) *propterygius* A. S. Woodward, Brit. Mus. Cat. Foss. Fishes, pt. IV, p. 464.

Type.—Imperfect fish; Paris Museum of Natural History.

Of this rare and imperfectly known species a single small example is preserved in the British Museum, and one measuring 15 cm. in total length in the Carnegie Museum (Cat. No. 4013, 4013a).

Division C. PERCIFORMES.

The principal characters of this large division are thus summarized by Dr. Boulenger: "Rays of the caudal fin not strongly forked at the base; hypural usually with a basal spine or knob-like process on each side, epipleural bones usually inserted on the parapophyses or on the ribs; dorsal fin usually with strong spines; caudal peduncle rarely much constricted." (*loc. cit.* p. 651.)

Family PERCIDÆ.

For figures of skulls and notes on the osteology of recent *Percidæ* see G. A. Boulenger, "Catalogue of the Perciform Fishes in the British Museum."

Genus LATES Cuvier and Valenciennes.

The existing species of this genus are tropical fresh-water forms.

31. *Lates gracilis* Agassiz. (Plate XCIV, fig. 2.)

1796. *Holocentrus calcarifer* G. S. Volta, Ittiolit. Veronese, p. 82, pl. XVII, fig. 3 (*errore*).
 1796. *Lutianus ephippium*, G. S. Volta, *ibid.*, p. 235, pl. LVI, fig. 4 (*errore*).
 1833-34. *Lates gracilis* L. Agassiz, Poiss. Foss., Vol. IV, p. 25, pl. III.
 1833-34. *Lates gibbus* L. Agassiz, *ibid.*, p. 27, pl. IV. (Distorted fish.)
 1833-34. *Lates notæus* L. Agassiz, *ibid.*, p. 29, pl. V. (Imperfect distorted fish; Paleontological Museum, Munich.)

1876. *Lates gracilis* F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 174.

1876. *Lates gibbus* F. Bassani, *ibid.*, p. 174.

1901. *Lates gracilis* A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, pt. IV, p. 502.

Type.—Well-preserved fish; Paris Museum of Natural History.

This species is represented in the Bayet Collection by a number of excellent examples. The complete series is cataloged as follows: 4348, 4352, 4465, 4501, 4515, 4516, 4517. Of these Nos. 4515 and 4501 are in counterpart. No. 4501 is figured on Plate XCIX, and is a young individual.

Genus CYCLOPOMA Agassiz.

An extinct genus scarcely distinguishable from *Lates*, but preoperculum without spine at angle, its serrations gradually increasing in size downwards, and the lowest and largest forwardly directed.

32. *Cyclopoma gigas* Agassiz.

1796. *Labrus turdus* G. S. Volta, Ittiolit. Veronese, p. 202, pl. XLIX (*errore*).

1796. *Scorpaena* G. S. Volta, *ibid.*, pl. LXXIV.

1833. *Cyclopoma gigas* L. Agassiz, Poiss. Foss., Vol. IV, p. 18, pl. II.

1901. *Cyclopoma gigas* A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, pt. IV, p. 504.

Type.—Imperfect fish; Paris Museum of Natural History.

Of this, the type species, which attains a length of half a meter, two examples are the property of the British Museum, and four belong to the Carnegie Museum. These are all very fine large specimens, cataloged under the following numbers: 4311 (from Monte Postale, Italy); 4358 (head in counterpart and peculiar in having four anal spines instead of three, the usual number), 4406 (very large, in counterpart), and 4405.

33. *Cyclopoma* (?) *micracanthum* (Agassiz). (Plate XCVII, fig. 4).

1796. *Holocentrus maculatus* G. S. Volta, Ittiolit. Veronese, p. 234, pl. LVI, fig. 3 (*errore*).

1796. *Amia indica* G. S. Volta, *ibid.*, p. 149, pl. XXXV, fig. 4 (*errore*).

1818. *Amia indica* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 347.

1835. *Smerdis micracanthus* L. Agassiz, Poiss. Foss., Vol. IV, p. 33, pl. VIII, figs. 1, 2.

1836. *Dules medius* L. Agassiz, *ibid.*, p. 93, pl. XIII, fig. 4. (Imperfect fish; Paleontological Museum, Munich.)

1901. *Cyclopoma* (?) *micracanthum* A. S. Woodward, Brit. Mus. Cat. Foss. Fishes, pt. IV, p. 504.

Type.—Imperfect fish; *olim* Hartmann Collection, Göttingen.

This small species, included by Agassiz under *Smerdis*, but transferred by A. Smith Woodward to *Cyclopoma* on account of its serrated preoperculum, is abundantly represented in the Upper Eocene of Monte Bolca. The Carnegie Museum possesses six good examples, cataloged as follows: 4210, 4211, 4221, 4226, 4228, 4519. No. 4228 is represented by fig. 4, Plate XCVII.

Under this caption may perhaps be included a small form, regarded by A. Smith Woodward as the young of *C. micracanthum*, but placed by Agassiz in a distinct species, *Smerdis pygmæus*. The specimen cataloged as No. 4212 is an example, and is illustrated in Plate XCVII, Fig. 5.

Genus LABRAX Cuvier and Valenciennes.

34. **Labrax schizurus** Agassiz.

1836. *Labrax schizurus* L. Agassiz, Poiss. Foss., Vol. IV, p. 89, pl. XIII, figs. 2, 3.
1901. *Labrax schizurus* A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, pt. IV, p. 510.

Type.—Imperfect fish; Paris Museum of Natural History.

This is a slender species attaining a total length of about 15 cm. It is represented by several specimens in the British Museum, and by a single small example in the Bayet Collection, cataloged as No. 4222.

35. **Labrax lepidotus** Agassiz.

1836. *Labrax lepidotus* Agassiz, Poiss. Foss., Vol. IV, p. 85, pl. XIII, fig. 1.

Type.—Fragmentary fish; Paleontological Museum, Munich.

Of this rare form two examples are known besides the type. One is the property of the Paris Museum of Natural History, the other belongs to the Carnegie Museum (Cat. No. 4356).

Genus DULES.

36. **Dules temnopterus** Agassiz.

1796. *Sciæna plumierii* G. S. Volta, Ittiolit. Veronese, p. 185, pl. XLV, fig. 2
(*errore*).

1836. *Dules temnopterus* L. Agassiz, Poiss. Foss., Vol. IV, p. 91, pl. 21.

1876. *Dules temnopterus* F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. 3, p. 175.

Type.—Imperfect fish; Paris Museum of Natural History.

No examples of this species are present in the British Museum and but one in the Carnegie Institute. This is catalogued as No. 4297.

Genus ENOPLONUS Agassiz.

37. **Enoplosus pygopterus** Agassiz.

1796. *Scomber ignobilis* G. S. Volta, Ittiolit. Veronese, pl. XIV, fig. 1 (*errore*).

1836-37. *Enoplosus pygopterus* L. Agassiz, Poiss. Foss., Vol. IV, p. 62, pl. IX, fig. 1.

1876. *Enoplosus pygopterus* F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 175.

Type.—Imperfect fish; Paris Museum of Natural History.

The type of this species has hitherto remained unique. A second interesting example is that belonging to the Bayet Collection of the Carnegie Museum, which is catalogued as No. 4218, 4218a.

Genus DENTEX.

Four species from the Upper Eocene of Monte Bolca have been referred by Agassiz to this interesting genus, the position of which is considered to be intermediate between the *Percidæ* and *Sparidæ*. None of these is represented in the collections of the British Museum, but examples of the undermentioned form are to be found in the Carnegie Institute.

38. **Dentex leptacanthus** Agassiz.

1839. *Dentex leptacanthus* Agassiz, Poiss. Foss., Vol. IV, p. 144, pl. XXVI.

Type.—Imperfect fish; Paris Museum of Natural History.

The following mentioned examples of this species are preserved in the Bayet Collection: 4309 (in counterpart), 4335, 4360.

Family SPARIDÆ. (Porgies, Sea-Breams.)

This family embraces some two hundred living species, distributed over the coasts of nearly the whole world. Some are herbivorous, but the majority are carnivorous. The group is abundantly represented in Eocene and Miocene deposits by remains of *Sargus*, *Sparus*, *Pagrus*, *Pagellus*, etc., and by the extinct genera *Ctenodentex*, *Sparnodus*, and *Trigonodon*.

Genus SPARNODUS Agassiz.

39. **Sparnodus vulgaris** (Blainville).

1796. *Sparus macrophthalmus* G. S. Volta, Ittiolit. Veronese, p. 247, pl. LX, fig. 2 (*errore*).

1796. *Cyprinus* G. S. Volta, *ibid.*, pl. LXXIII.
1796. *Sparus dentex* G. S. Volta, *ibid.*, p. 62, pl. XIII, fig. 1 (*errore*).
1796. *Sparus sargus* G. S. Volta, *ibid.*, p. 76, pl. XVII, fig. 1 (*errore*).
1796. *Sparus erythrinus* G. S. Volta, *ibid.*, p. 249, pl. LX, fig. 3 (*errore*).
1818. *Sparus vulgaris* H. D. de Blainville, *Nouv. Dict. d'Hist. Nat.*, Vol. XXVII, p. 349.
1835. *Sparnodus macrophthalmus* L. Agassiz, *Neues Jahrb.*, p. 300 (name only).
1835. *Sparnodus ovalis* L. Agassiz, *ibid.*, p. 300 (name only).
1835. *Sparnodus altivelis* L. Agassiz, *ibid.*, p. 300 (name only).
1835. *Sparnodus micracanthus* L. Agassiz, *ibid.*, p. 300 (name only).
1839. *Sparnodus macrophthalmus* L. Agassiz, *Poiss. Foss.*, Vol. IV, p. 158, pl. XXVIII, fig. 3.
1839. *Sparnodus ovalis* L. Agassiz, *ibid.*, p. 161, pl. XXIX, fig. 2. (Imperfect fish; Paris Museum of Natural History.)
1839. *Sparnodus altivelis* L. Agassiz, *ibid.*, p. 162, pl. XXIX, fig. 3. (Ditto.)
1839. *Sparnodus micracanthus* L. Agassiz, *ibid.*, p. 164, pl. XXVIII, fig. 2, pl. XXIX, fig. 1. (Ditto.)
1886. *Sparnodus lethriniformis* W. Szajnocha, *Pamiet. Wydz. matem.-przyr. Akad. Umiej. Krakow*, Vol. XII, p. 106, pl. I, fig. 1. (Imperfect fish; University Geological Museum, Cracow).
1876. *Sparnodus ovalis* F. Bassani, *Atti. Soc. Veneto-Trent. Sci. Nat.*, Vol. III, p. 177.
1876. *Sparnodus micracanthus* F. Bassani, *ibid.*, p. 177.
1901. *Sparnodus macrophthalmus* A. S. Woodward, *Brit. Mus. Cat. Fossil Fishes*, pt. IV, p. 525.

Type.—Imperfect fish; Paris Museum of Natural History.

This, the type species, is represented by numerous examples in the collection which are indicated as follows: 4000, 4000a, 4001, 4002, 4002a, 4004, 4536, 4538, 4538a, 4544, 4543, 4535, 4538, 4538a, 4461 (its counterpart = No. 4337), 4462, 4460, 4005 and 4005a (distorted specimen), 4503, 4537, 4537a, 4354, 4539, 4317 (= counterpart of 4462), 4329, 4336, 4535.

40. ***Sparnodus elongatus*** Agassiz. (Plate XCI, fig. 3; Plate XCVIII, fig. 2.)
1796. *Perca radula* ? G. S. Volta, *Ittiolit. Veronese*, p. 134, pl. XXXI, fig. 1 (*errore*).
1796. *Sparus chromis* G. S. Volta, *ibid.*, p. 138, pl. XXXII, fig. 1 (*errore*).
1796. *Sparus salpa* G. S. Volta, *ibid.*, p. 230, pl. LVI, fig. 1 (*errore*).
1835. *Sparnodus elongatus* L. Agassiz, *Neues Jahrb.*, p. 300 (name only).

1835. *Serranus ventralis* L. Agassiz, *ibid.*, p. 293 (name only).
 1839. *Serranus ventralis* L. Agassiz, Poiss. Foss., Vol. 4, p. 104, pl. XXIIIb
 (lower figure). (Imperfect fish; Paris Museum of Natural History).
 1839. *Sparnodus elongatus* L. Agassiz, *ibid.*, p. 165, pl. XXVIII, fig. 1.
 1901. *Sparnodus elongatus* A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, pt.
 IV, p. 526.

Type.—Imperfect fish; Paris Museum of Natural History.

The following mentioned specimens in the collection are referable to this species: 4540, 4541, 4541a, 4542, 4542a, 4416, 4447. Nos. 4416 and 4542 are illustrated in the accompanying plates.

Family POMACENTRIDÆ.

Genus ODONTEUS Agassiz.

To this extinct genus have been assigned two small-sized species from the Eocene of Monte Bolca, neither of which is represented in the collections of the British Museum, and only the following one is in the Carnegie Institute.

41. **Odonteus sparoides** Agassiz. (Plate XCVII, fig. 1.)

1839. *Odonteus sparoides* L. Agassiz, Poiss. Foss., Vol. IV, p. 178, pl. XXXIX,
 fig. 2.
 1876. *Odonteus sparoides* F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III,
 p. 176.
 1898. *Odonteus sparoides*, var. *depressus* F. Bassani, Palæont. Italica, Vol. III,
 p. 83, pl. VIII, fig. 2.

Type.—Imperfect fish; Paris Museum of Natural History.

One example of this rare form is preserved in the collection, cataloged as No. 4208. It is shown of the natural size in Plate XCVII, fig. 1.

Division D. CHÆTODONTIFORMES.

As *Perciformes*, but brain-case very short, and facial region of skull much produced, with terminal small mouth.

Family CHÆTODONTIDÆ.

This group comprises about two hundred living marine species from the tropics, mostly of small size and remarkable for their singular forms and markings, and brilliant coloration. They are particularly abundant about volcanic rocks and coral reefs.

Genus PYGÆUS Agassiz.

42. **Pygæus nuchalis** Agassiz.

1835. *Pygæus nuchalis* L. Agassiz, Neues Jahrb., p. 302.

1838-44. *Pygæus nuchalis* L. Agassiz, Poiss. Foss., Vol. IV, pp. 16,* 255, pl. XLIV, fig. 2.

Type.—Imperfect fish; Paris Museum of Natural History.

This unsatisfactorily known form is not represented in the collections of the British Museum. A single small example in the Bayet Collection, cataloged as No. 4232, is doubtfully referable to this position, and with it may be placed the fragment numbered 4217.

Genus EPHIPPUS Cuvier.

43. **Ephippus rhombus** (Blainville). (Plate XCII, fig. 2.)

1796. *Chaetodon mesoleucus* G. S. Volta, Ittiolit. Veronese, p. 41, pl. X, fig. 1 (errore).

1796. *Chaetodon chirurgus* G. S. Volta, *ibid.*, p. 177, pl. XLIII.

1818. *Chaetodon chirurgus* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 353.

1818. *Chaetodon rhombus* H. D. de Blainville, *ibid.*, p. 353.

1823. *Chaetodon rhomboides* J. F. Krüger, Gesch. Urwelt, pt. II, p. 671.

1842-44. *Ephippus longipennis* L. Agassiz, Poiss. Foss., Vol. IV, pp. 15, 225, pl. XL. (Imperfect fish; Paris Museum of Natural History.)

1859. *Ephippus longipennis* A. B. Massalongo, Specimen Photogr. Anim. Foss. Agr. Veron., p. 34, pl. IX.

1901. *Ephippus rhombus* A. S. Woodward, British Museum Catalogue Fossil Fishes, pt. IV, p. 559.

Type.—Imperfect fish; Paris Museum of Natural History.

One fine example of this species is preserved in the Bayet Collection, cataloged as No. 4463 + 4463a. It is somewhat smaller than the type, although nearly as perfect, but fails to display ova in the abdominal cavity as some others do. No. 4463 is illustrated in Plate XCII, fig. 2.

44. **Ephippus oblongus** Agassiz.

1796. *Chaetodon asper* G. S. Volta, Ittiolit. Veronese, p. 90, pl. XX, fig. 1.

1818. *Chaetodon substriatus* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 352.

1835. *Ephippus oblongus* L. Agassiz, Neues Jahrb., p. 292.

- 1839-44. *Ephippus oblongus* L. Agassiz, Poiss. Foss., Vol. IV, pp. 15, 228, pl. XXXIX, fig. 3.

Type.—Imperfect fish; Paris Museum of Natural History.

No example of this species is to be found in the British Museum collections, and but one in the Bayet Collection of the Carnegie Institute. This is an imperfectly preserved fish cataloged as No. 5238.

Genus SCATOPHAGUS.

45. **Scatophagus frontalis** Agassiz.

1796. *Chaetodon argus* G. S. Volta, Ittiolit. Veronese, p. 44, pl. X, fig. 2 (errore).
 1831. *Chaetodon argus* Cuvier and Valenciennes, Hist. Nat. Poiss., Vol. VII, p. 145 (errore).
 1835. *Scatophagus frontalis* L. Agassiz, Neues Jahrb., p. 291.
 1839-42. *Scatophagus frontalis* L. Agassiz, Poiss. Foss., Vol. IV, p. 231, pl. XXXIX, fig. 4.
 1859. *Scatophagus frontalis* A. B. Massalongo, Specimen Photogr. Anim. Foss. Agr. Veron., p. 32, pl. VIII.

Type.—Imperfect fish; Paris Museum of Natural History.

Unrepresented in most foreign collections, including that of the British Museum, this species may be studied to excellent advantage from the fine suite of specimens belonging to the Carnegie Museum. These are cataloged under the following numbers: 4014, 4014a, 4021, 4355, 5355a, 4463, 4463a, 4464, 4449, 4449a, 4452, 5239, 4450 and its counterpart No. 4478.

Family ACRONURIDÆ.

These are herbivorous, partly carnivorous, fishes common in tropical seas in the vicinity of coral reefs. The existing genera *Naseus* and *Acanthurus* have Eocene representatives.

Genus NASEUS Cuvier.

The skeleton of the existing *Naseus brevirostris* is described by Dr. Günther in his Catalogue of Fishes in the British Museum, Vol. 3, 1861, p. 349.

46. **Naseus nuchalis** Agassiz.

1796. *Chaetodon nigricans* G. S. Volta, Ittiolit. Veronese, p. 100, pl. XXII, fig. 1.
 1835. *Naseus nuchalis* L. Agassiz, Neues Jahrb., p. 292.
 1838-42. *Naseus nuchalis* L. Agassiz, Poiss. Foss., Vol. IV, pp. 13, 212, pl. XXXVI, fig. 2.

Type.—Imperfect fish; Paris Museum of Natural History.

This rare form is represented in the Bayet Collection of the Carnegie Museum by an exceedingly handsome specimen, cataloged as No. 4454.

47. **Naseus rectifrons** Agassiz. (Plate XCVII, fig. 2.)
1796. *Chaetodon triostegus* G. S. Volta, Ittiolit. Veronese, p. 143, pl. XXXIII (errore).
1818. *Chaetodon triostegus* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 354.
- 1838-42. *Naseus rectifrons* L. Agassiz, Poiss. Foss., Vol. IV, pp. 13, 213, pl. XXXVI, fig. 3.
1859. *Naseus rectifrons* A. B. Massalongo, Specimen Photogr. Anim. Foss. Agr. Veron., p. 22, pl. XII, fig. 1.
1876. *Naseus rectifrons* F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 178.
1901. *Naseus rectifrons* A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, pt. IV, p. 565.

Type.—Imperfect fish; Paris Museum of Natural History.

Two examples of this species are preserved in the Bayet Collection, one small and imperfect, the other a fine large example, both in counterpart. These are cataloged under the numbers 4441 and 4362 (in counterpart), No. 4441a is the specimen illustrated in Plate XCVII, Fig. 2. The British Museum possesses three specimens.

Genus ACANTHURUS Forskål.

With lateral caudal spines; spinous portion of dorsal fin less extended than articulated portion; anal fin with three spines.

For a description of the skeleton of the existing *A. triostegus*, by Dr. Günther, see Cat. Fishes Brit. Mus. (1861), Vol. III, p. 327.

No fossil representatives of this genus are preserved in the British Museum, nor are examples of either of the species described by Agassiz from the Eocene of Monte Bolca to be found in the collections of the Carnegie Museum. One specimen occurs, however, cataloged as No. 4342, and having a total length of 15 cm., which probably belongs to an undescribed species of this genus.

Division ZEORHOMBI.

Family AMPHISTIIDÆ.

This extinct family, known only by the Upper Eocene *Amphistium paradoxum*, originally described as a *Pleuronectes*, is placed by Boulenger in close association

with the Zeidæ, from which it differs in the smaller number of vertebræ (10+14), and in having the dorsal and anal spines more reduced, adnate, and continuous with the series of soft rays. Ventral fins with one spine and eight soft rays. This fish, according to the author just mentioned, appears to realize in every respect

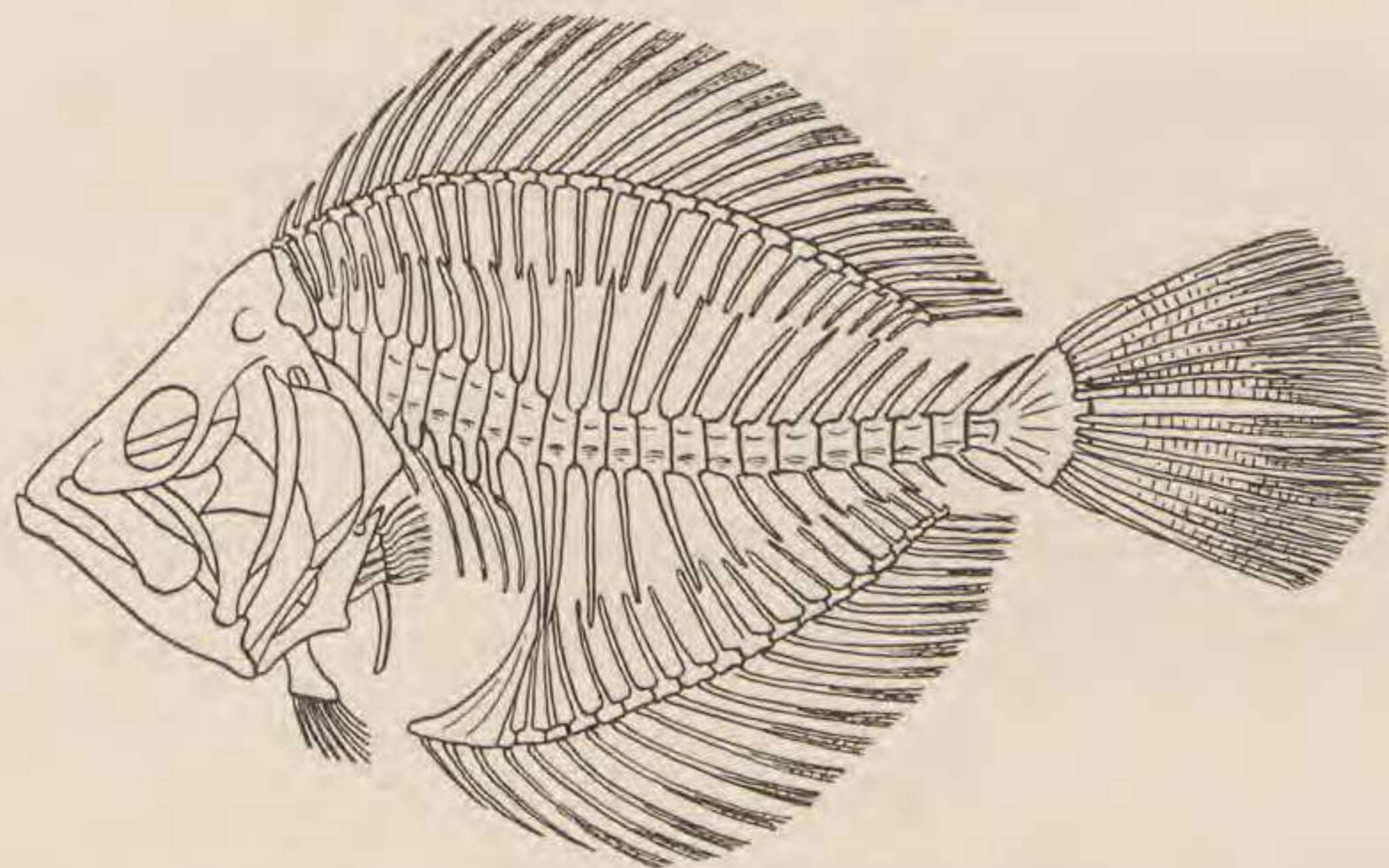


FIG. 4. *Amphistium paradoxum* Agassiz. Upper Eocene, Monte Bolca, Italy. Restored after Boulenger. About one half natural size.

the prototype of the Pleuronectidæ before they had assumed the asymmetry which characterizes them as a group. No examples of *Amphistium* are contained in the collection.

Family PLEURONECTIDÆ.

This family first appears in the Upper Eocene of Monte Bolca, but no extinct genera are recognizable. Modern Flat-fishes form a large group of some 500 species, mostly marine, but a few species related to the Soles are confined to fresh water.

Genus RHOMBUS (Klein) Cuvier.

48. *Rhombus minimus* Agassiz. (Plate XCVI, fig. 3.)

1796. *Pleuronectes quadratulus* G. S. Volta, Ittiolit. Veronese, p. 260, pl. LXIII, fig. 3 (*errore*).
1835. *Rhombus minimus* L. Agassiz, Neues Jahrb., p. 301 (name only).
- 1839-42. *Rhombus minimus* L. Agassiz, Poiss. Foss., Vol. IV, p. 289, pl. XXXIV, fig. 1.
1859. *Rhombus minimus* A. B. Massalongo, Specimen Photogr. Anim. Foss. Agr. Veron. (1859), p. 36, pl. XIII, fig. 1.
1901. *Rhombus minimus* A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, Pt. IV, p. 607.

Type.—Nearly complete fish; Paleontological Museum, Munich.

Two good examples of this species are preserved in the collection of the British Museum, and as many in that of the Carnegie Museum. These are cataloged as follows: 4433, 4433a, 4457, 4457a. One of these is shown in Plate XCVI, fig. 3.

Division GOBIIFORMES.

According to Boulenger the Gobies, which constitute this division, are not very remote from the *Perciformes*, and may have evolved out of a type not very different from the *Percidæ*.

SYNOPSIS OF FAMILIES REPRESENTED BY EXTINCT GENERA OR SPECIES.

All abdominal vertebræ with large transverse processes supporting ribs.... *Gobiidæ*.
Abdominal vertebræ without transverse processes..... *Trachinidæ*.

Family GOBIIDÆ.

The so-called *Gobius microcephalus* Agassiz, the systematic position of which is doubtful, may be provisionally retained in this family, to which Agassiz first assigned it. The typical specimen is preserved in the British Museum of Natural History, and another, nearly as perfect, in the Bayet Collection of the Carnegie Museum (No. 4504). This is shown in Plate XCVI, fig. 4, twice enlarged.

Family TRACHINIDÆ.

Genus CALLIPTERYX Agassiz.

This extinct genus is known only by two species from the marine Upper Eocene of Italy.

49. *Callipteryx speciosus* Agassiz. (Plate CI, fig. 1.)

1796. *Gadus merluccius* G. S. Volta, Ittiolit. Veronese, p. 72, pl. XV (*errore*).

1835. *Callipteryx speciosus* L. Agassiz, Neues Jahrb., p. 293 (name only).

1838-42. *Callipteryx speciosus* L. Agassiz, Poiss. Foss., Vol. IV, pp. 12, 196, pl. XXXIII, fig. 2.

1901. *Callipteryx speciosus* A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, pt. IV, p. 589.

Type.—Imperfect fish; Paris Museum of Natural History.

This is a large form, attaining a total length of about 70 cm. It is not represented in the collections of the British Museum, but two fine specimens belonging to it are preserved in the Carnegie Museum. These are cataloged as Nos. 4404 (in counterpart) and 5244.

50. *Callipteryx recticaudus* Agassiz.

1796. *Trigla lyra* G. S. Volta, Ittiolit. Veronese, p. 121, pl. XXX (*errore*).
 1835. *Callipteryx recticaudus* L. Agassiz, Neues Jahrb., p. 300 (name only).
 1838-42. *Callipteryx recticaudus* L. Agassiz, Poiss. Foss., Vol. IV, pp. 12, 198,
 pl. XXXIII, fig. 2.
 1901. *Callipteryx recticaudus* A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, pt.
 IV, p. 589.

Type.—Imperfect distorted fish; Paris Museum of Natural History.

A smaller and more slender species than the type, attaining a length of about 50 cm. One specimen is included in the published Catalog of the British Museum, and three belong to the Carnegie Museum, also a detached caudal fin, probably of this species. These bear the following departmental numbers: 4403 (in counterpart), 4207, 4313, 4518 (caudal fin in counterpart).

Division SCLEROPAREI.

Second suborbital bone more or less produced towards or ankylosed with the preoperculum ("suborbital stay"). Ventral fins thoracic.

As remarked by Boulenger, the "cheek-armoured Acanthopterygians," "Joues cuirassées" of Cuvier, after the exclusion of the Sticklebacks, form a perfectly natural association, evidently derived from the *Serranidae*, with which the more generalized forms have much in common.

Family COTTIDÆ.

Descriptions and figures of the skeleton of existing *Cottidæ* are given by C. Girard, "A Monograph of the Cottoids," *Smithson. Contrib.*, Vol. III, Art. No. 3 (1850).

Genus EOCOTTUS. A. S. Woodward.

This extinct genus is known by a solitary species from the marine Upper Eocene of Monte Bolca. According to Heckel, this species is closely related to *Callipteryx*, but it is distinguished from that genus by the presence of scales and the short and stout form of the dermal arches in the abdominal region.

51. *Eocottus veronensis* (Volta). (Plate XCIX, fig. 1. Figure inverted.)
 1796. *Gobius barbatus* G. S. Volta, Ittiolit. Veronese, p. 48, pl. XI, fig. 1.
 1796. *Gobius veronensis* G. S. Volta, *ibid.*, p. 51, pl. XI, fig. 2.
 1818. *Gobius veronensis* H. D. de Blainville, *Nouv. Dict. d'Hist. Nat.*, Vol. XXVII,
 p. 358.

1835. *Gobius macrourus* L. Agassiz, Neues Jahrb., p. 291 (name only).
 1838-39. *Gobius macrurus* L. Agassiz, Poiss. Foss., Vol. IV, pp. 12, 203, pl. XXXIV, figs. 3, 4.
 1876. *Gobius macrurus* F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 180.
 1901. *Eocottus veronensis* A. S. Woodward, Brit. Mus. Cat. Foss. Fishes, pt. IV, p. 581.

Type.—Imperfect fish; Paris Museum of Natural History.

Of this form only one well-preserved specimen has hitherto been known besides the type, this being the property of the British Museum of Natural History. Three examples are contained in the Bayet Collection of the Carnegie Museum, designated as follows: Cat. Nos. 4233, 4439, and 4512.

Division BLENNIIFORMES.

Pectoral fins with much extended base or flank; pelvic fins jugular, reduced or absent. Dorsal fin-spines numerous, but usually flexible. No bony stay between circumorbital ring and preoperculum.

Family BLOCHIIDÆ.

This family is known by a single Eocene genus, founded by Volta in 1796.

52. *Blochius longirostris* Volta. (Text figure 5a.)

1796. *Blochius longirostris* G. S. Volta, Ittiolit. Veronese, p. 53, pls. XII, LXX.
 1843-44. *Blochius longirostris*, L. Agassiz, Poiss. Foss., Vol. II, pt. II, p. 255, pl. XLIV.
 1887. *Blochius macropterus* A. de Zigno, Mem. R. Istit. Veneto, Vol. XXIII, p. 25, fig. 7.
 1901. *Blochius longirostris* A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, pt. IV, p. 593.

Type.—Imperfect fish; Paris Museum of Natural History.

This highly specialized and remarkable form, by Woodward regarded as descended from the same ancestral stock as gave rise to the Blennies, by Boulenger placed in association with the Sail-fishes (*Histiophoridae* and extinct *Palæorhynchidae*), is not only typical of the genus, but has remained hitherto the only known representative of it and of the family *Blochiidae*. In all, four examples are preserved in the Bayet Collection of the Carnegie Museum, two large-sized and well-preserved individuals, and two smaller specimens, one of them evidently immature.

These are cataloged as Nos. 4500 (young example, imperfect), 4312 (small but complete), 4546 (total length 70 cm., of which the head, from base of occiput to the extremity of rostrum measures 30 cm.), and 4520 (in counterpart, total length 60 cm.).

In addition to the four specimens just mentioned, the head in natural association with a few anterior vertebræ and fin-portions of an enormous example of *Blochius*, occurs in the Bayet Collection, and is to be seen on exhibition in the Hall of Fossil Vertebrates in the Museum. Notwithstanding its imperfect condition, the form and proportion of the preserved parts are such as to leave little doubt that the huge head in question pertains to a distinct species, the description of which immediately follows.

53. *Blochius moorheadi*, sp. nov. (Text figure 5.)

Type.—Nearly complete head in natural association with anterior vertebræ and portions of the pectoral fins; Carnegie Museum.

A relatively gigantic species, estimated to have attained a total length of between 2.5 and 3 metres, thus greatly exceeding the average size of individuals belonging to the type species. Further noteworthy differences are to be seen in the general configuration and relative proportions of the head parts, especially in the gently sloping outline of the cranial roof, depressed form of the head posteriorly, and consequent shortening of the opercular apparatus. The abrupt downward slope of the facial region in advance of the orbits, which is so marked a feature in *B. longirostris* is here missing, and the orbit itself appears to be more posteriorly situated than in the type species. The vertebræ are of the usual hour-glass form, and larger than those of *Cybium* or other known contemporaries among bony fishes.

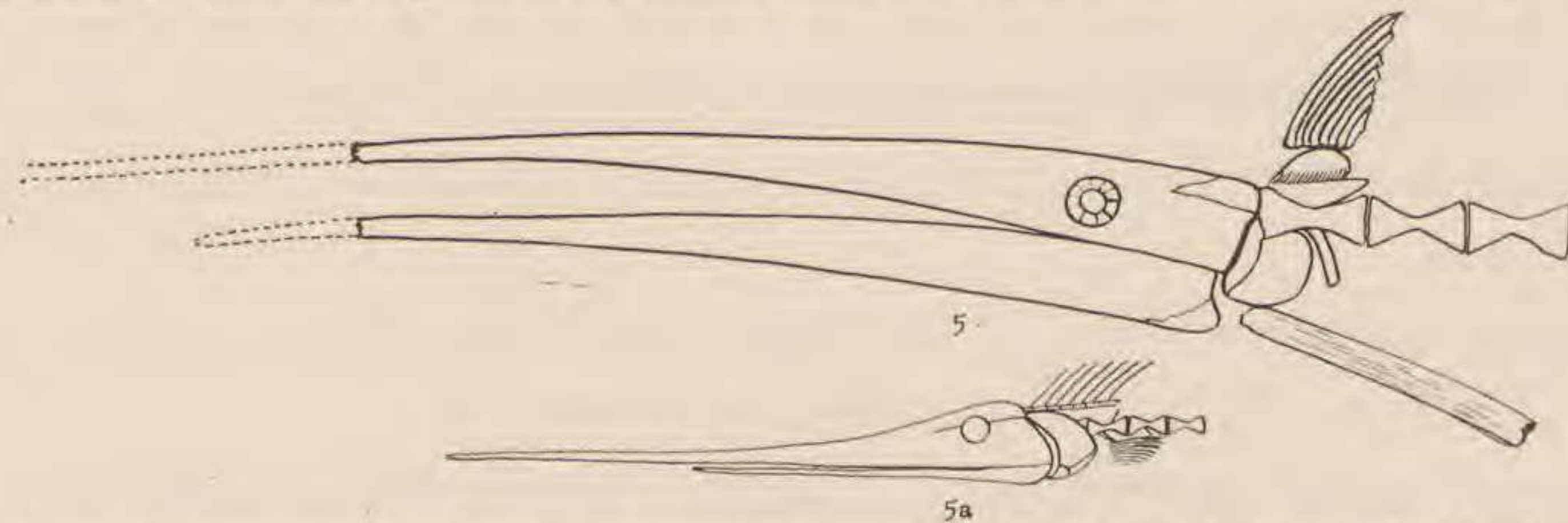


FIG. 5. *Blochius moorheadi*, sp. nov. Anterior portion of type specimen, preserved in the Carnegie Museum. Sclerotic ring partially preserved; pectoral fin-rays displaced. Greatly reduced.

FIG. 5a. *Blochius longirostris* Volta. Complete head and anterior portion of the trunk, showing much-elongated rostrum and form of opercular plates. (After A. S. Woodward.) $\times 1/10$.

Owing to the crushed condition of the cheek-plates and opercular apparatus, a restoration of these parts has not been attempted in the annexed diagram, but

the probable arrangement of these parts may be inferred from a comparison with the same structure in *B. longirostris*, an outline figure of which is given above (5a).

The specific title proposed for this remarkable new form is bestowed in honor of Mr. Moorhead B. Holland of Pittsburgh, son of the Director of the Museum, and friend of the writer, who rendered efficient aid in the task of superintending the transfer of the Bayet Collection from Brussels to this country during the summer of 1903.

Family BLENNIDÆ.

Elongated fishes with stout caudal pedicle, due to an expanded hypural; snout not produced. Dorsal fin occupying nearly the whole of the back, often subdivided; anal fin also much extended; caudal fin rounded or tapering.

Modern species are marine, living at the bottom near almost all coasts. Most of them are carnivorous, but a few are herbivorous; some are viviparous (*Clinus*), others oviparous. The habits of *Blennius* are interesting, and have been admirably described by Guitel (Arch. Zool. Expérim., 1893, sér. 3, Vol. I, p. 325). The male makes a sort of nest and defends the brood.

GENUS PTERYGOCEPHALUS Agassiz.

This extinct genus, known only from the Eocene, and erroneously identified with the existing *Cristiceps* by J. Müller, is thus diagnosed by A. Smith Woodward:

"Head short and orbit very large; mouth small, with conical teeth. Vertebrae about 10 in the abdominal, 14 in the caudal region. Dorsal fin very deep, the foremost large spine displaced forwards above the head, but the fin otherwise continuous. Squamation well developed and continuous, each scale with a longitudinal keel, and the keels forming regular lines along the trunk."

54. ***Pterygocephalus paradoxus*** Agassiz. (Plate XCVI, fig. 5.)
1796. *Labrus malapterus* G. S. Volta, Ittiolit. Veronese, p. 228, pl. LV, fig. 3 (errore).
1818. *Labrus malapterus*, H. D. de Blainville, Nouv. Diet. d'Hist. Nat., Vol. XXVII, p. 351.
1835. *Pterygocephalus paradoxus* L. Agassiz, Neues Jahrb., p. 295 (name only).
1839. *Pterygocephalus paradoxus* L. Agassiz, Poiss. Foss., Vol. IV, p. 191, pl. XXXII, figs. 5, 6.
1876. *Cristiceps paradoxus*, F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 178.
1901. *Pterygocephalus paradoxus*, A. S. Woodward, Brit. Mus. Cat. Fossil Fishes, pt. IV, p. 595.

Type.—Imperfect fish; Paris Museum of Natural History.

Two examples of this rare and interesting species are recorded as belonging to the British Museum of Natural History, and one each is to be found in the Harvard and Pittsburgh Museums, in this country. That belonging to the latter institution is a fair specimen, showing the characteristic squamation, and cataloged under the number 4215. It is shown of twice the natural size in the accompanying plate.

Suborder PEDICULATI.

This is a small, natural group, connected with the *Acanthopterygii jugulares* through the *Batrachidæ*, in which the elongate pterygials foreshadow the kind of "arm" or pseudobranchium which generally characterizes these highly aberrant Fishes. Dr. Theodore Gill has recently contributed a valuable paper on this group.

Family ANTENNARIIDÆ.

"Mouth large, vertical or very oblique, turned upwards, with cardiform teeth. Gill-opening in or behind lower axil of pectoral; no pseudobranchiæ. Pectoral fin forming an elbow-like angle, with three pterygials. Ventral with four or five rays. Spinous dorsal present. Skin naked or spinulose."

According to Dr. Boulenger, from whom we have taken the above family diagnosis, this group comprises about forty recent species, distributed among five genera: *Pterophryne*, *Antennarius*, *Brachionichthys*, *Saccarius*, and *Chaunax*. "The species of *Antennarius*," says the same author, "live mostly in coral groves, where they lie in wait for prey, well-concealed by the protective coloration and the harmonizing aspect of their integument and appendages. To this genus also belongs the 'Marbled Angler' (*A. marmoratus*), carried about in mid-ocean among the *Sargassum* weed, to rest on which, from its peculiar arm-like pectoral fins, it is especially fitted; there it makes its wonderful nest of silk-like fibres probably secreted by the parent as in the Sticklebacks, with large bundles of eggs hanging like grape clusters."

Genus HISTIONOTOPHORUS Eastman.

(Syn. *Histiocephalus* Zigno.)

This extinct genus, known only by the typical species, is one of the rarest of all the components of the Eocene fish-fauna of Monte Bolca. Its systematic relations have been discussed by Dr. Theodore Gill and the present writer, and attention has been called to it as a remarkable instance of a form of fish-life appearing suddenly in the Eocene, already highly modified, without any known predecessors nor any that can be plausibly conjectured, but which persists after its first

introduction essentially unchanged until modern times. In the opinion of Dr. Gill, its nearest allies in the existing fauna are to be found in *Antennarius* itself and *Pterophryne*.

55. **Histionotophorus bassani** (Zigno).

1887. *Histiocephalus bassani* A. de Zigno, Mem. R. Istit. Veneto, XXIII, p. 31, fig. 9.

1904. *Histionotophorus bassani* C. R. Eastman, Bull. Mus. Comp. Zool., XLVI, p. 32, pl. 1, figs. 1-3, text fig. c.

1904. *Histionotophorus bassani* T. Gill, *Science*, n. s., p. 845.

Besides the type and three well-preserved specimens that are now the property of the Museum of Comparative Zoology at Cambridge, Mass., but one other representative of this species is known. It is a small form in the Bayet Collection of the Carnegie Museum, cataloged as No. 5237.

Suborder PLECTOGNATHI.

This is a highly aberrant group, closely connected with the *Acanthopterygii* through the *Acanthuridae*, as pointed out long ago by Daresté (*Ann. Sci. Nat. Zool.* (3), xiv, 1850, p. 105). These fishes have usually been arranged in three divisions: *Sclerodermi*, *Ostracodermi*, and *Gymnodontes*, but Mr. C. T. Regan has shown reasons for combining the second of these with the first and third. Following is Boulenger's diagnosis of the latter of these divisions:

Division GYMNODONTES.

"Supraclavicle oblique, sometimes nearly horizontal; lower three pectoral pterygials enlarged and immovably united to the coraco-scapular cartilage, upper pterygial small, suturally united to the scapula. Anterior vertebræ with bifid divergent neural spines. Basis cranii simple; suture between dentary and articular elements evident. Pelvis absent."

The above definition of this group is further characterized by the same author as follows: "The spinous dorsal and the ventral fins are constantly absent, the premaxillaries are united to the maxillaries, and the teeth are coalescent, forming a beak; parapophyses are not developed, and epipleurals are absent.

Family DIODONTIDÆ.

Beak without median suture. Interoperculum rod-like, attached posteriorly to the rod-like anterior limb of the suboperculum. Gills 3. All the precaudal vertebræ with bifid neural spines. Skin with movable spines; vertebræ 21 or 22.

Of the two modern genera comprised by this family, *Diodon* and *Lyosphaera*, the former occurs fossil from the Eocene onwards and is represented by numerous species. Only a few are known from the Upper Eocene horizon of Monte Bolca, the most important being *D. erinaceus* and *D. tenuispinus* Agassiz. Examples of both of these occur in the Bayet Collection of the Carnegie Museum, and are cataloged under the following numbers: 4498 (*D. erinaceus* Agassiz); 4442, 4443 (*D. tenuispinus* Agassiz).

INDEX OF GENERA.

| | | | |
|-----------------------|-----|----------------------|-----|
| Acanthonemus..... | 370 | Leptocephalus..... | 358 |
| Acanthurus..... | 382 | Lichia..... | 367 |
| Anguilla..... | 357 | Mene..... | 366 |
| Aulostoma..... | 361 | Myripristis..... | 363 |
| Auxis..... | 373 | Naseus..... | 381 |
| Blochius..... | 386 | Odonteus..... | 379 |
| Callipteryx..... | 384 | Platax..... | 365 |
| Carangopsis..... | 368 | Pterygocephalus..... | 388 |
| Carcharias..... | 353 | Pycnodus..... | 355 |
| Centriscus..... | 362 | Pygæus..... | 380 |
| Clupea..... | 356 | Rhamphognathus..... | 359 |
| Cyclopoma..... | 375 | Rhamphosus..... | 362 |
| Dentex..... | 377 | Rhombus..... | 383 |
| Diodon..... | 391 | Scatophagus..... | 381 |
| Ductor..... | 369 | Scoliodon..... | 353 |
| Dules..... | 376 | Seriola..... | 367 |
| Enoplosus..... | 377 | Serranus..... | 379 |
| Eocottus..... | 385 | Semioporus..... | 365 |
| Eomyrus..... | 357 | Sparnodus..... | 377 |
| Ephippus..... | 380 | Sphyræna..... | 359 |
| Fistularia..... | 361 | Thynnus..... | 372 |
| Gobius..... | 384 | Trachynotus..... | 370 |
| Holocentrum..... | 364 | Trygon..... | 352 |
| Histionotophorus..... | 389 | Urosphen..... | 361 |
| Labrax..... | 376 | Vomeropsis..... | 366 |
| Labrus..... | 388 | Zanclus..... | 371 |
| Lates..... | 374 | | |

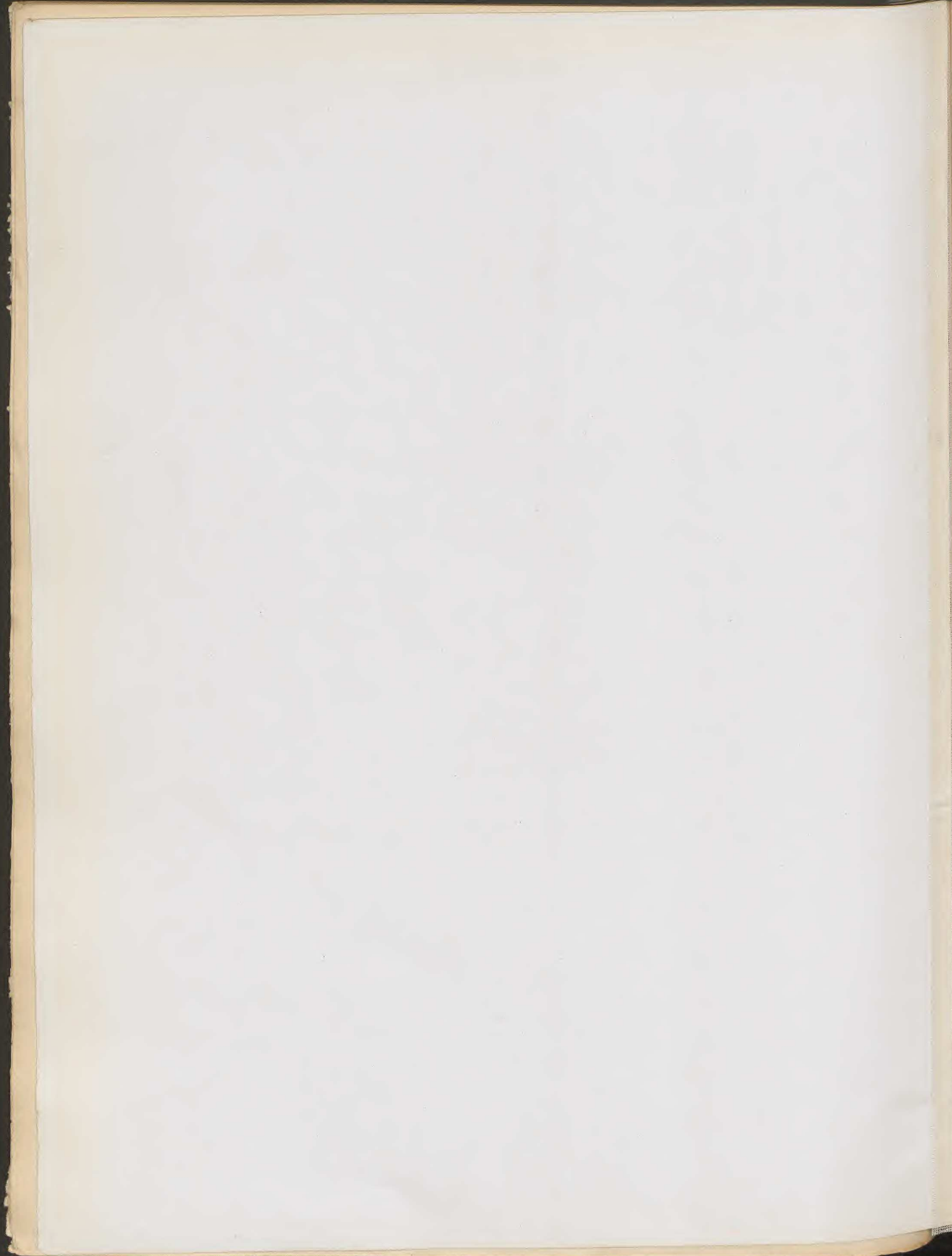
EXPLANATION OF PLATES.

PLATE XC.

- Fig. 1. *Eomyrus formosissimus* Eastman (*ex* Agassiz MS.). C. M. Cat. 5233. $\times 5/6$.
Fig. 2. *Urosphen dubia* (Blainville). C. M. Cat. No. 4015. $\times 6/7$.
Fig. 3. *Blochius longirostris* Volta. Immature example. C. M. Cat. No. 4312. $\times 8/9$.



1. *Eomyrus formosissimus* EASTMAN, $\frac{5}{8}$. 2. *Urosphen dubia* (BLAINVILLE), slightly reduced. 3. *Blochius longirostris* VOLTA, somewhat reduced. $\frac{1}{2}$.



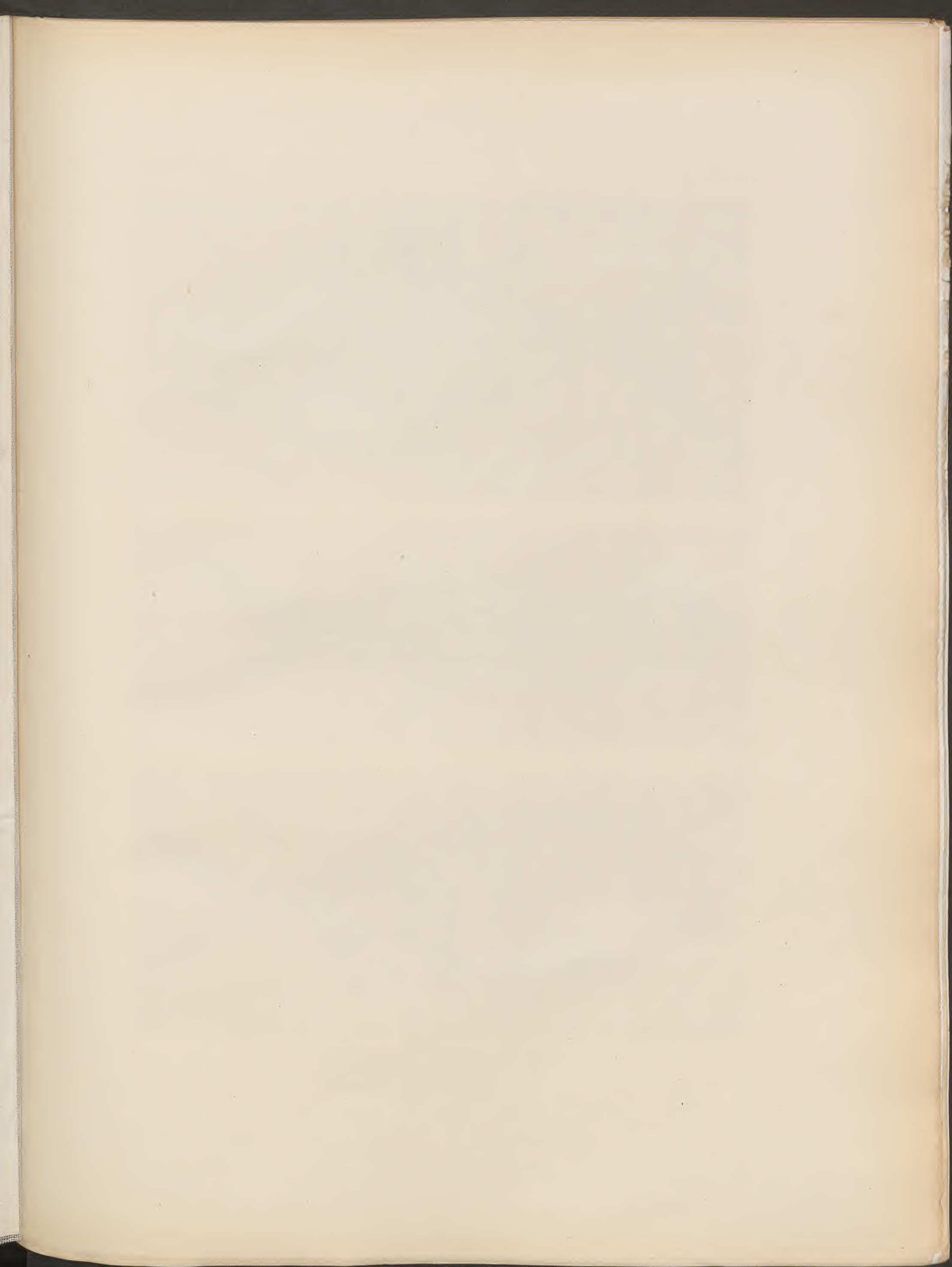
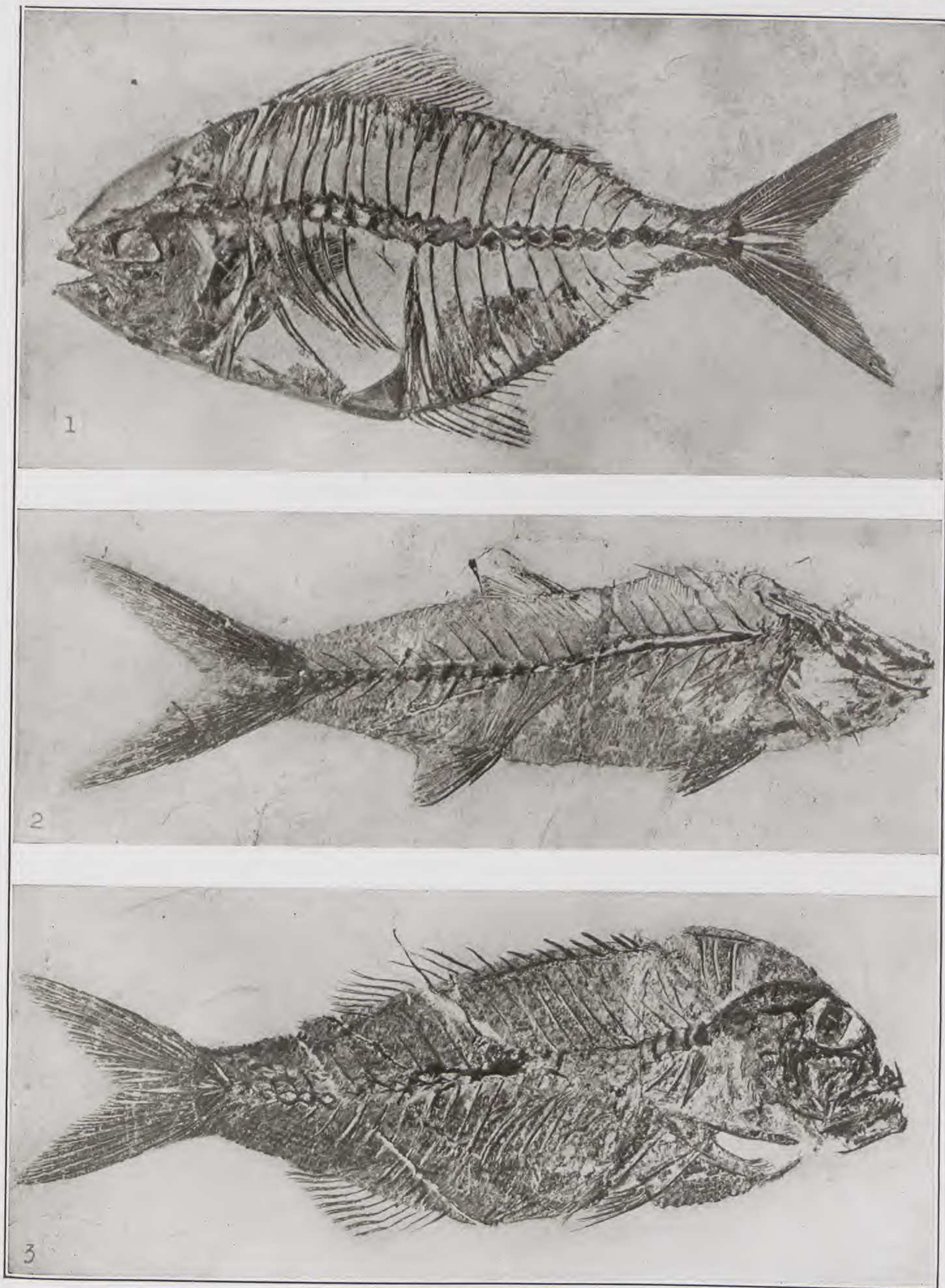
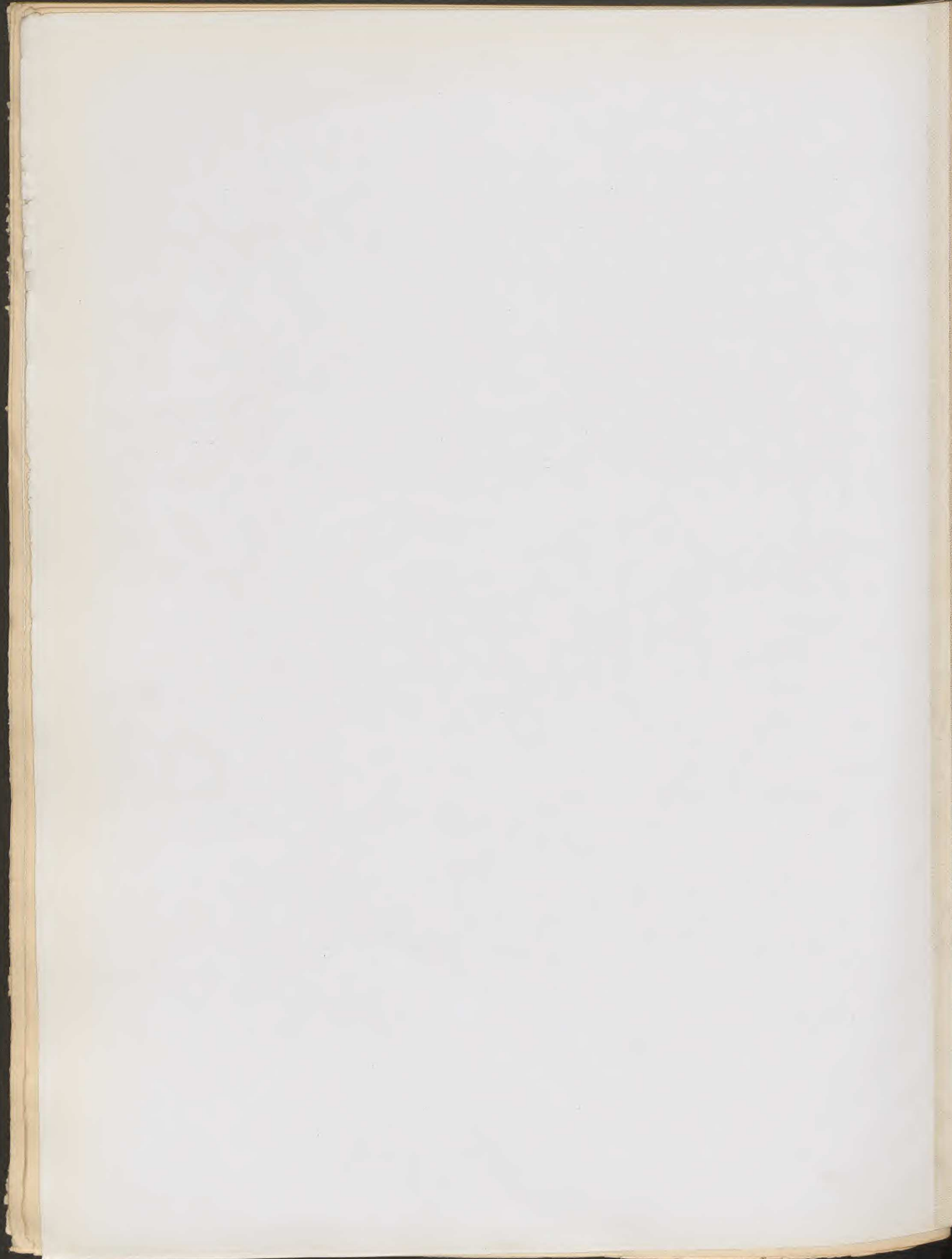


PLATE XCI.

- Fig. 1. *Trachynotus tenuiceps* Agassiz. C. M. Cat. No. 4532. $\times 1/1$.
Fig. 2. *Carangopsis dorsalis* Agassiz. C. M. Cat. No. 4537. $\times 1/1$.
Fig. 3. *Sparnodus elongatus* Agassiz. C. M. Cat. No. 4542. $\times 1/1$.



1. *Trachynotus tenuiceps* AGASSIZ. $\times \frac{1}{4}$.
2. *Carangopsis dorsalis* AGASSIZ. $\times \frac{1}{4}$.
3. *Sparnodus elongatus* AGASSIZ. $\times \frac{1}{4}$.



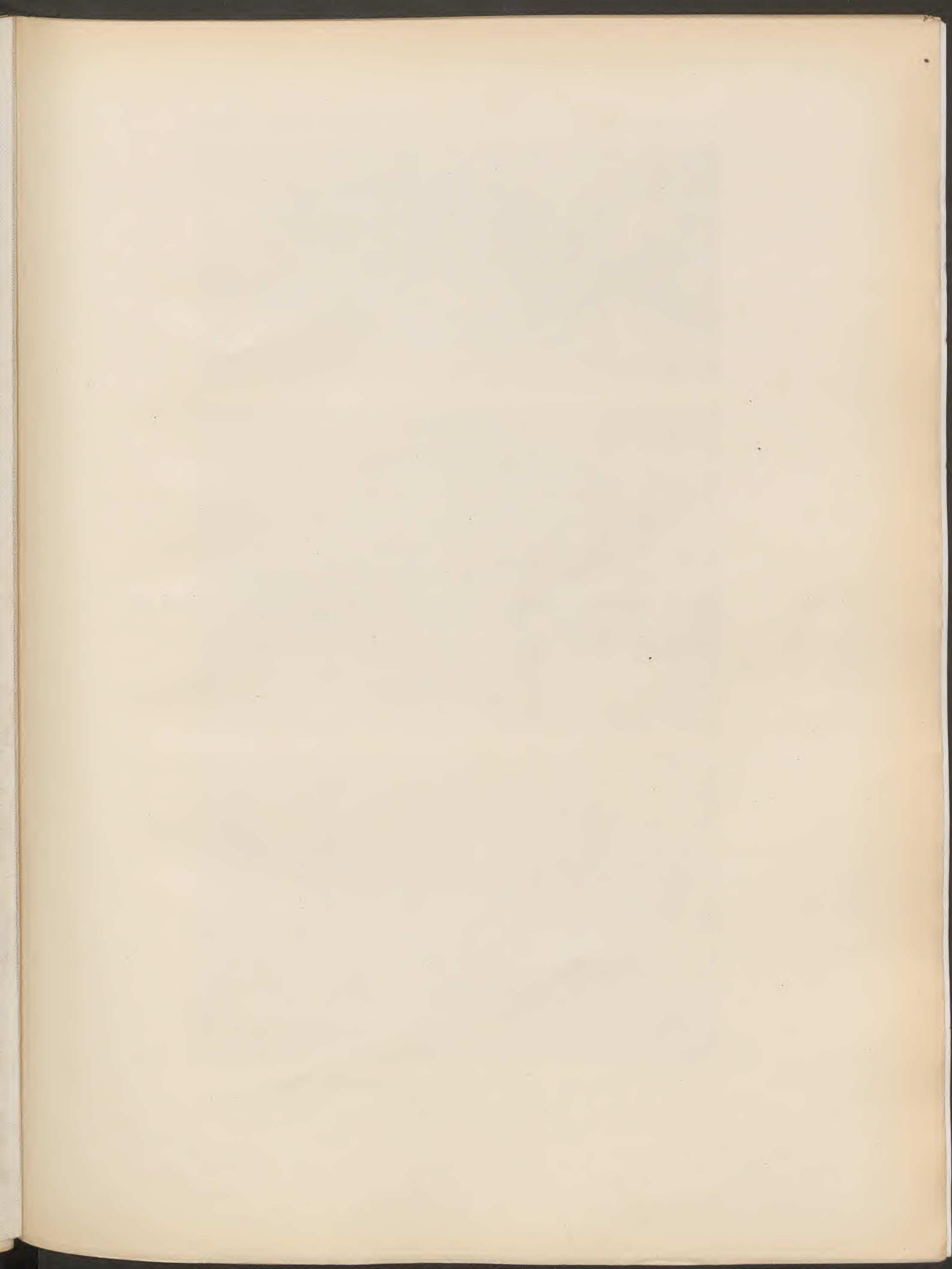
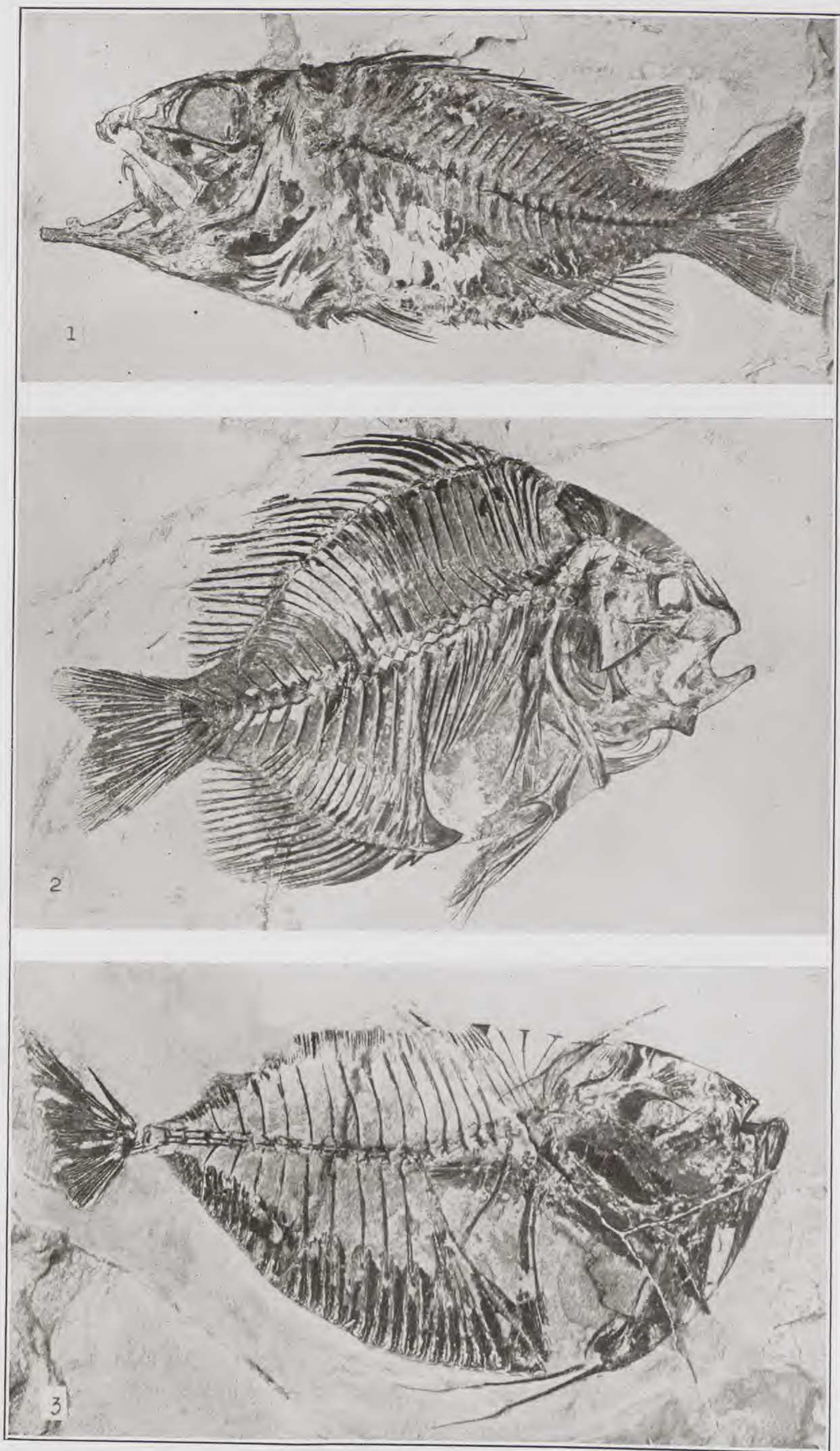
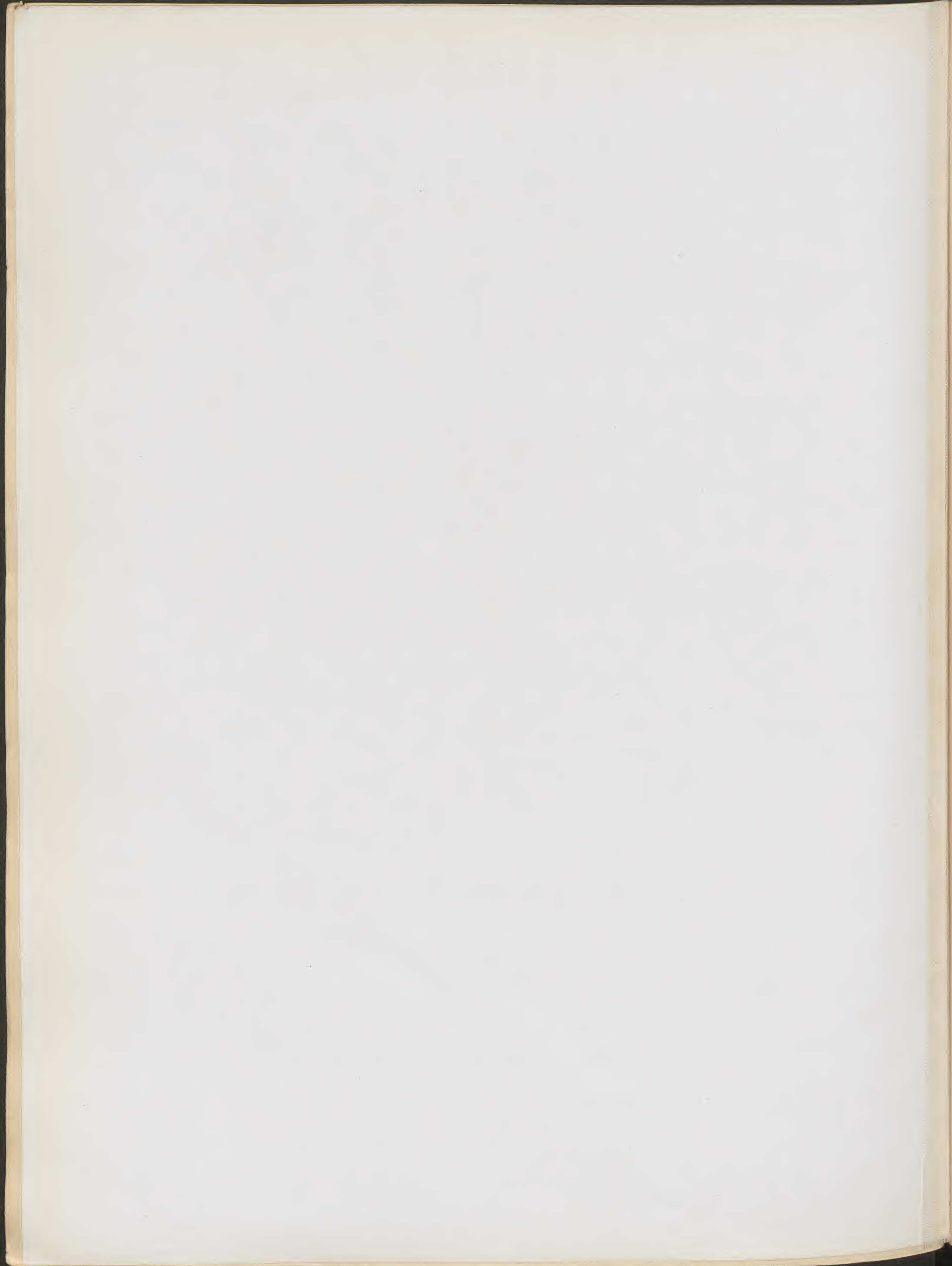


PLATE XCII.

- Fig. 1. *Holocentrum macrocephalum* (Blainville). C. M. Cat. No. 4455. Reduced 1/5.
Fig. 2. *Ephippus rhombus* (Blainville). C. M. Cat. No. 4463. Reduced 1/5.
Fig. 3. *Mene oblonga* (Agassiz). C. M. Cat. No. 4020. Reduced 1/5.



1. *Holocentrum macrocephalum* (BLAINVILLE). Reduced $\frac{1}{5}$.
2. *Ephippus rhombus* (BLAINVILLE). Reduced $\frac{1}{5}$.
3. *Mene oblonga* (AGASSIZ). Reduced $\frac{1}{5}$.



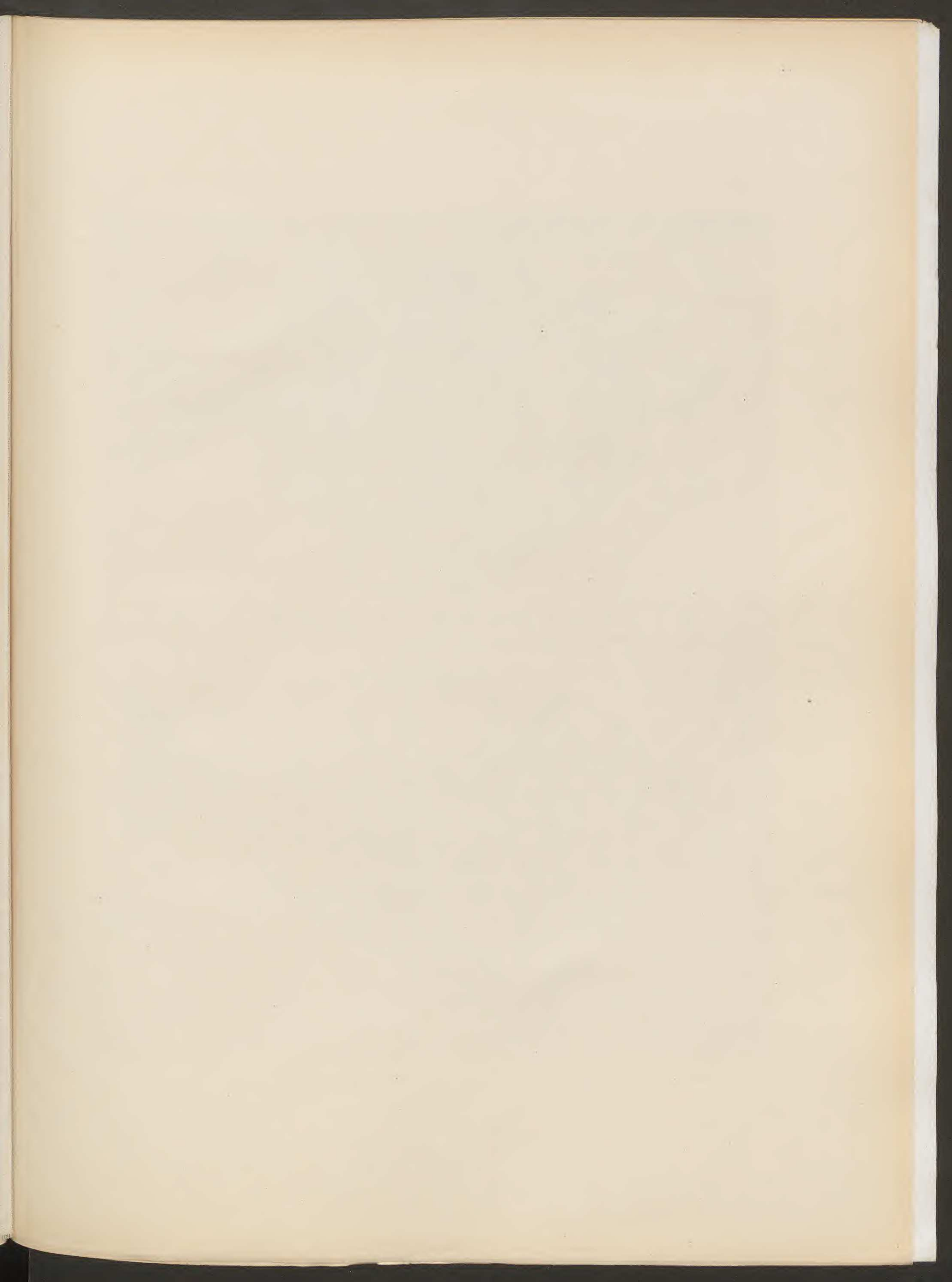
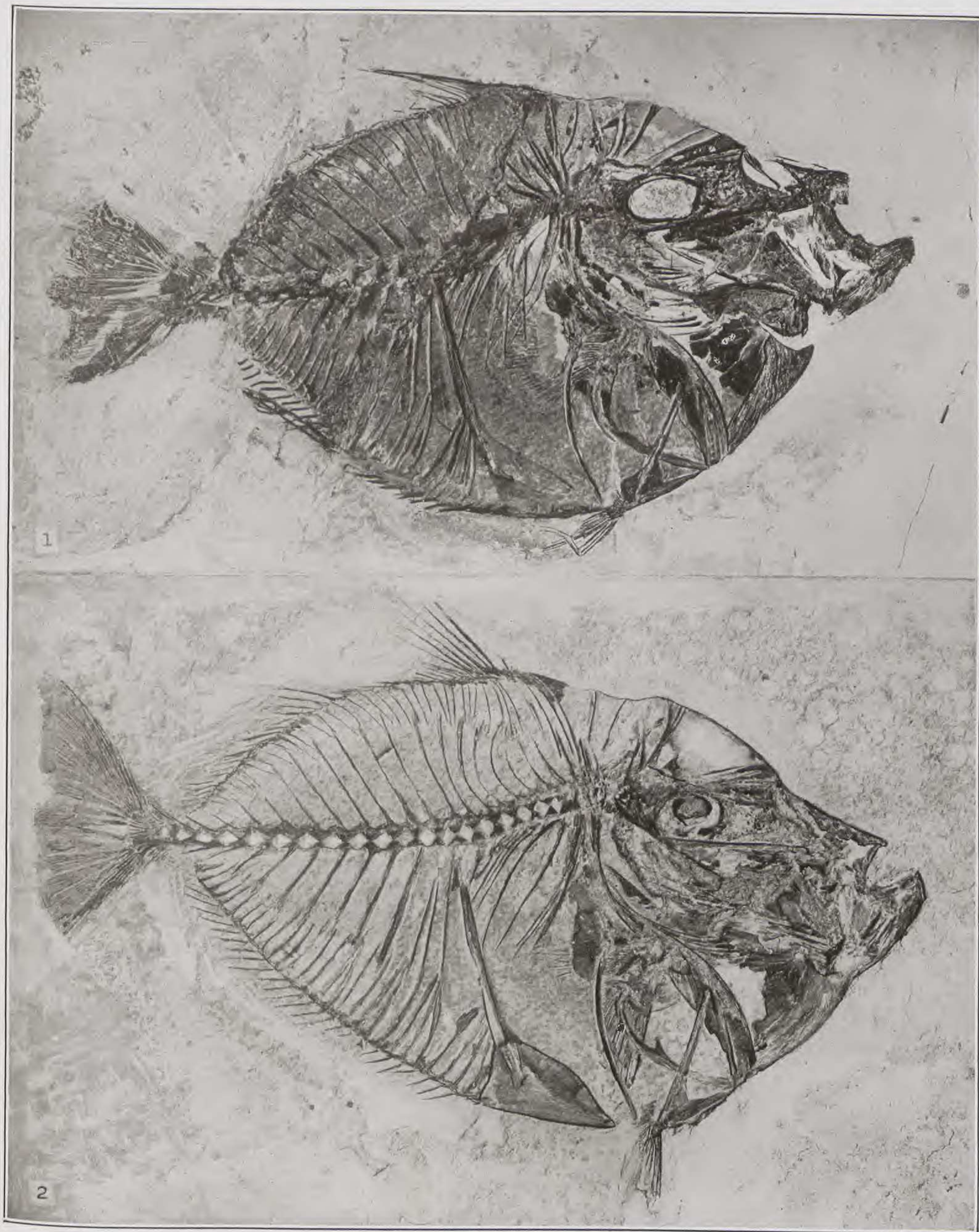
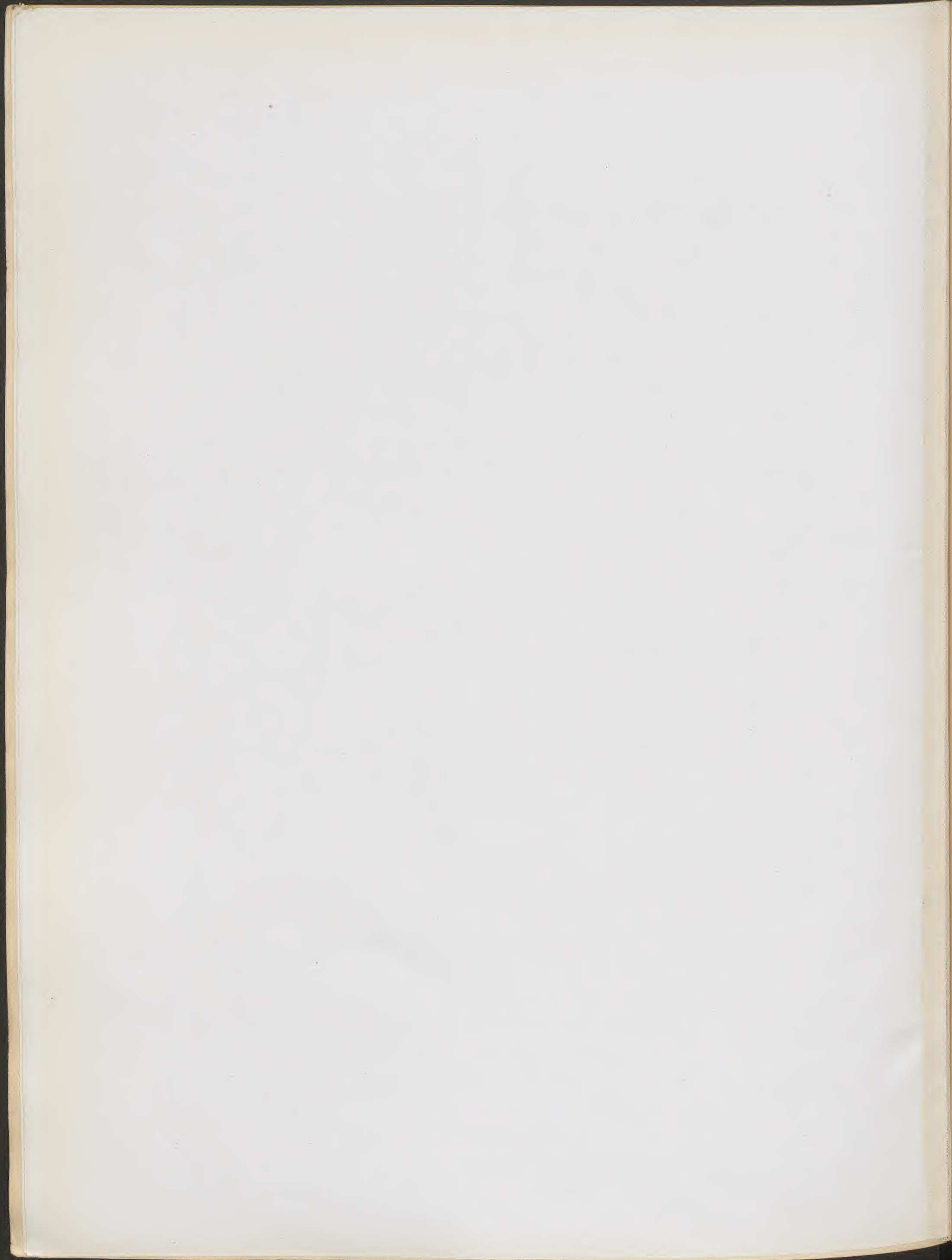


PLATE XCIII.

- Fig. 1. *Vomeropsis longispinus* Agassiz. C. M. Cat. No. 4489a. × 1/1.
Fig. 2. *Vomeropsis longispinus* Agassiz. C. M. Cat. No. 4350. × 1/1.



1-2. *Vomeropsis longispinus* AGASSIZ. Figures slightly reduced. $\frac{1}{5}$.



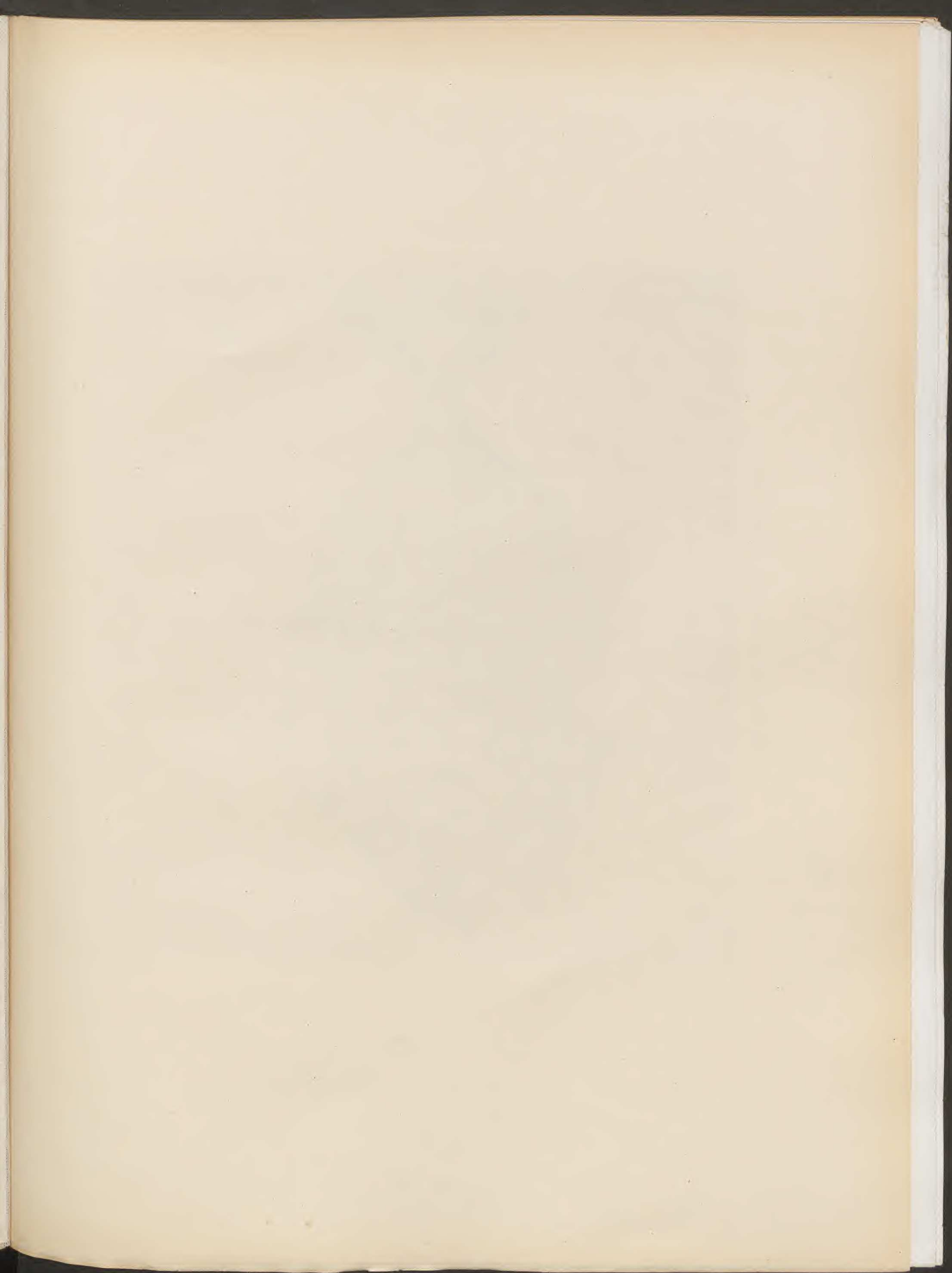
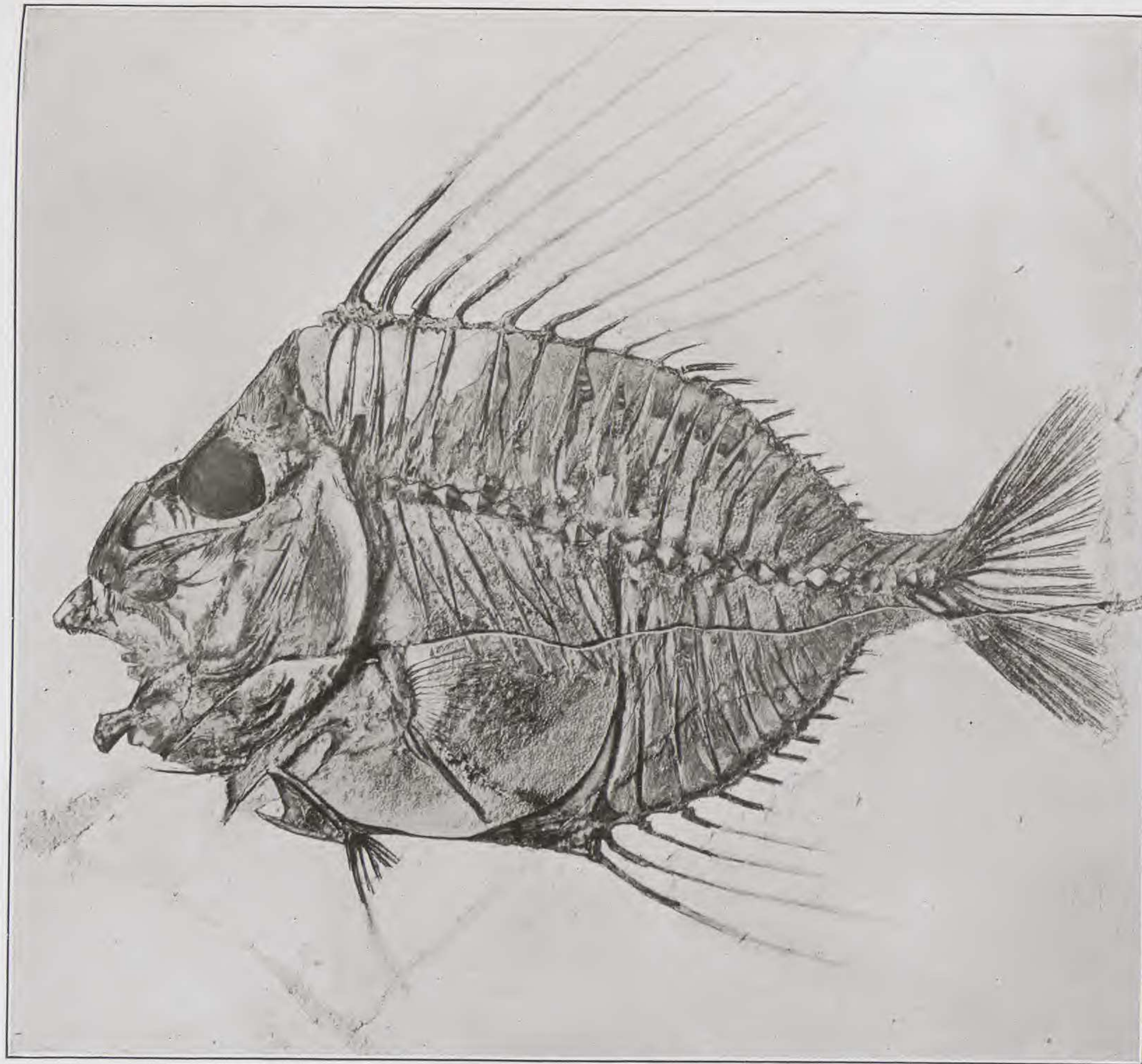
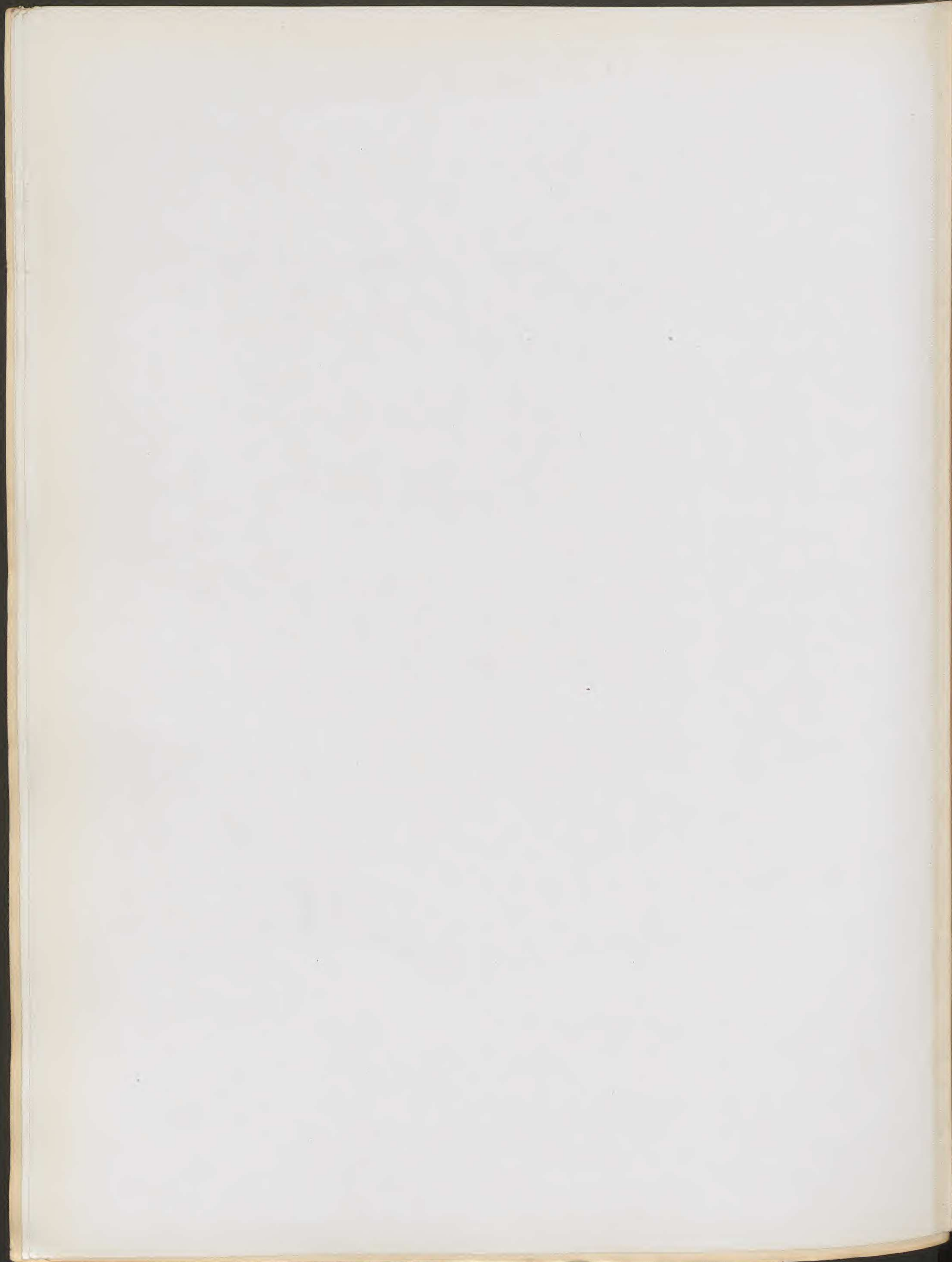


PLATE XCIV.

Acanthonemus subaureus (Blainville). C. M. Cat. No. 4439. × 14/15.



Acanthonemus subaureus BLAINVILLE. $\frac{1}{3}$ natural size.



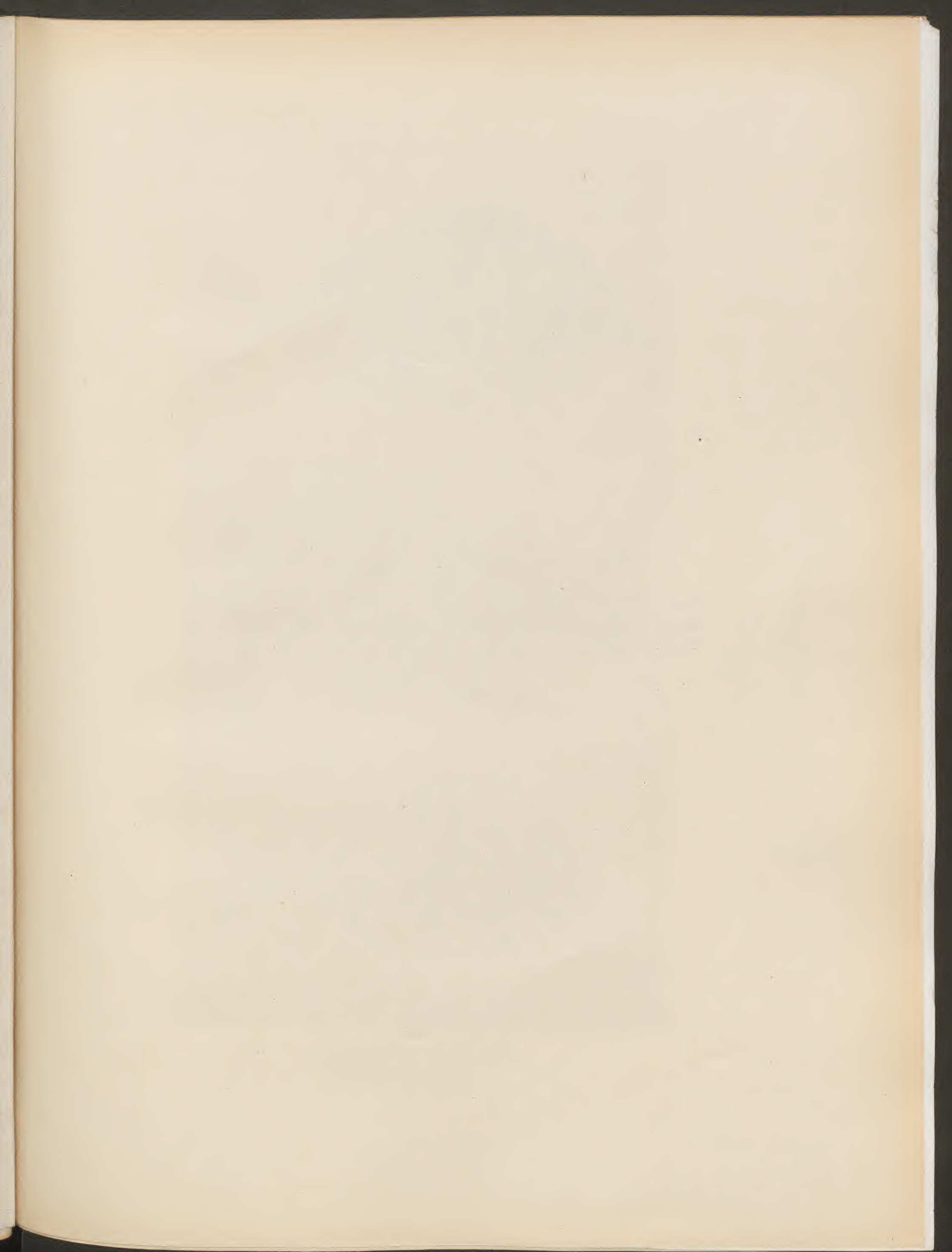
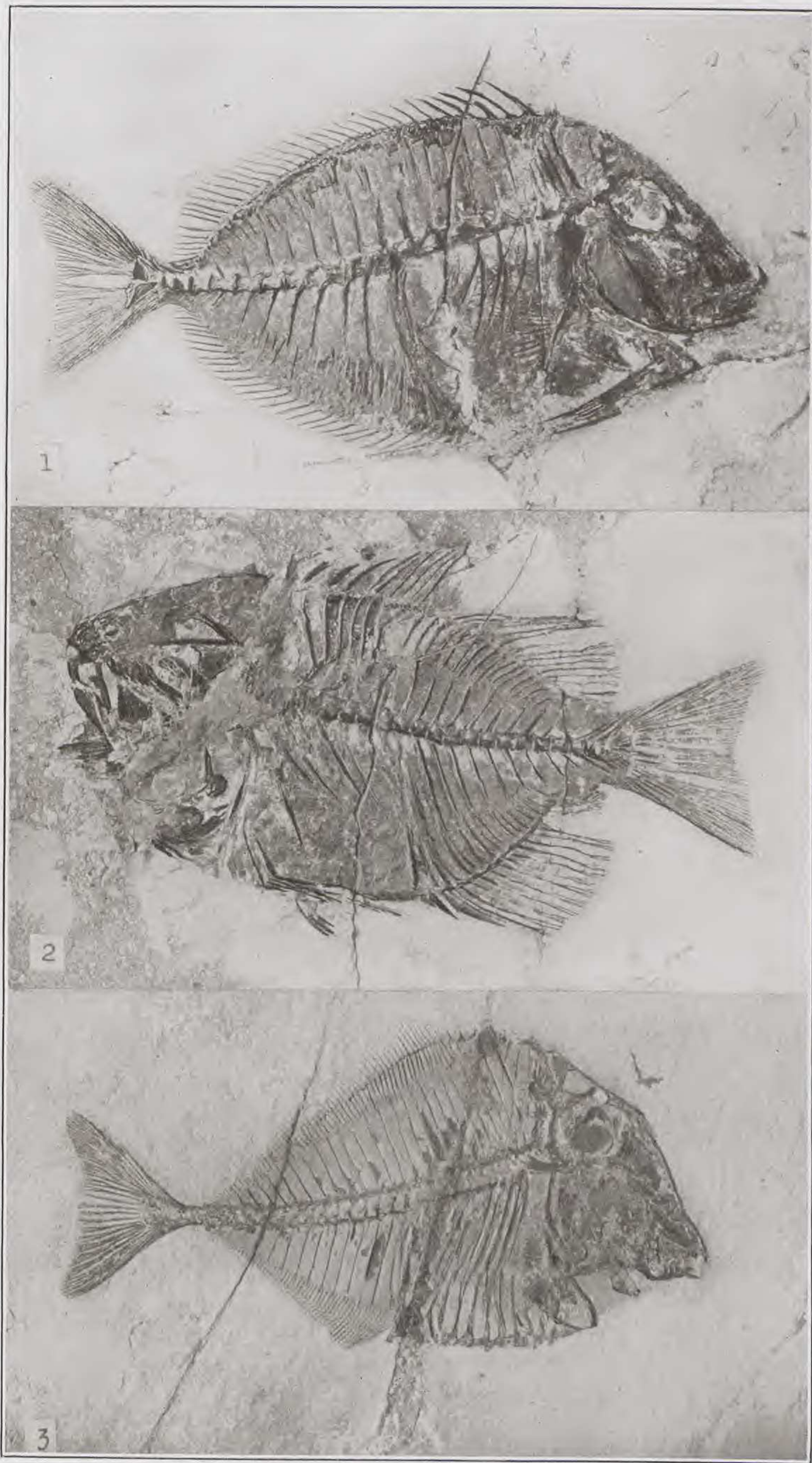


PLATE XCV.

- Fig. 1. *Naseus nuchalis* Agassiz. C. M. Cat. No. 4454. $\times 1/1$.
Fig. 2. *Ephippus oblongus* Agassiz. C. M. Cat. No. 5238. $\times 1/1$.
Fig. 3. *Pycnodus gibbus* Agassiz. C. M. Cat. No. 4480. $\times 1/1$.



1. *Naseus nuchalis* AGASSIZ. $\times \frac{1}{4}$.
2. *Ephippus oblongus* AGASSIZ. $\times \frac{1}{4}$.
3. *Pycnodus gibbus* AGASSIZ. $\times \frac{1}{4}$.

At 10:00

11:00

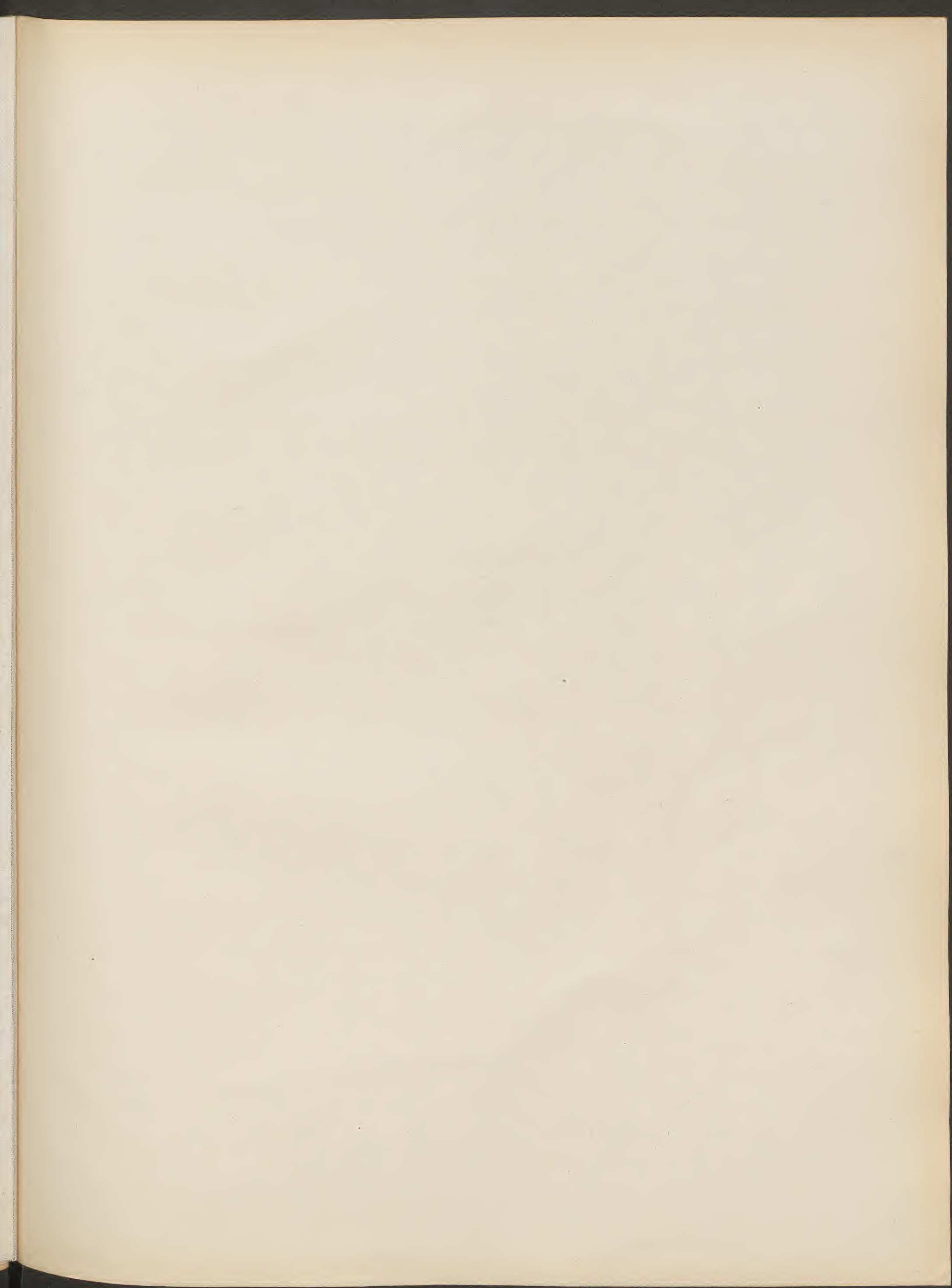
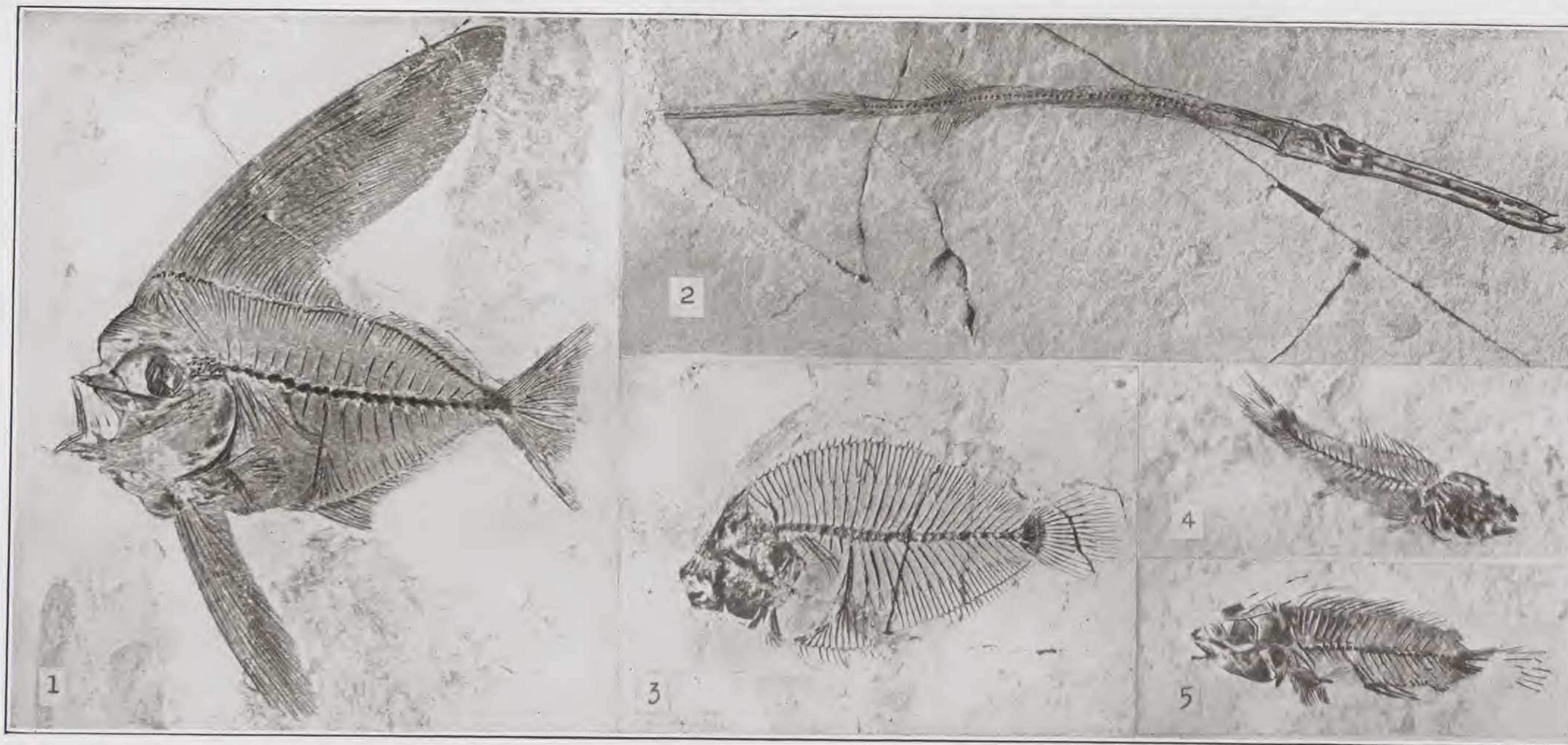
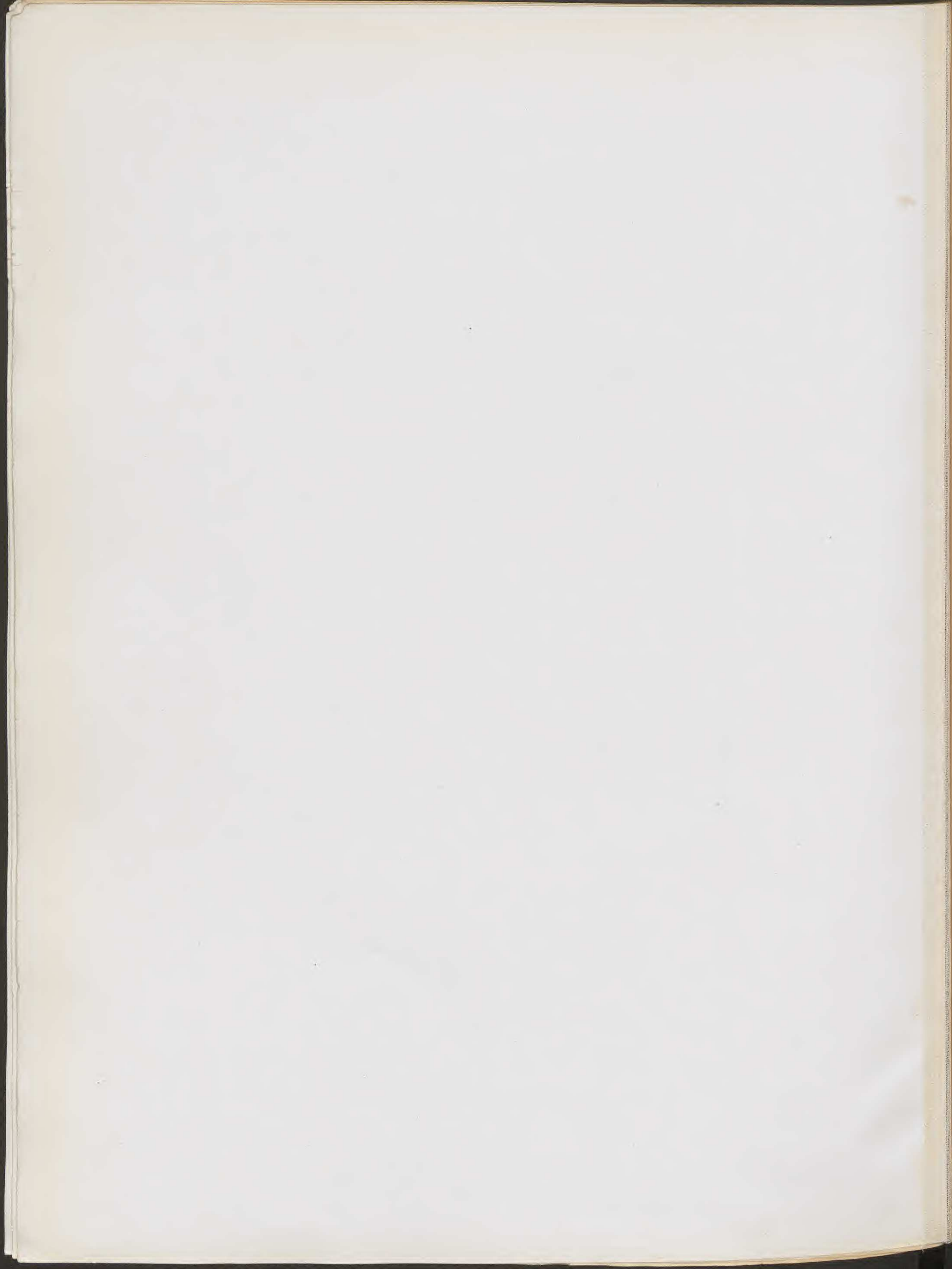


PLATE XCVI.

- Fig. 1. *Semiophorus velifer* (Volta). C. M. Cat. No. 4467. Original specimen previously figured by Massalongo. Slightly reduced.
- Fig. 2. *Urosphen dubia* (Blainville). C. M. Cat. No. 4499. Slightly reduced.
- Fig. 3. *Rhombus minimus* Agassiz. C. M. Cat. No. 4457. $\times 1/1$.
- Fig. 4. *Gobius microcephalus* Agassiz. C. M. Cat. No. 4504. $2/1$.
- Fig. 5. *Pterygocephalus paradoxus* Agassiz. C. M. Cat. No. 4215. $\times 2/1$.



1. *Semiophorus velifer* (VOLTA). 2. *Urosphen dubia* (BLAINVILLE). 3. *Rhombus minimus* AGASSIZ. $\times \frac{1}{4}$. 4. *Gobius microcephalus* AGASSIZ. $\times \frac{2}{3}$.
5. *Pterygocephalus paradoxus* AGASSIZ. $\times \frac{2}{3}$.



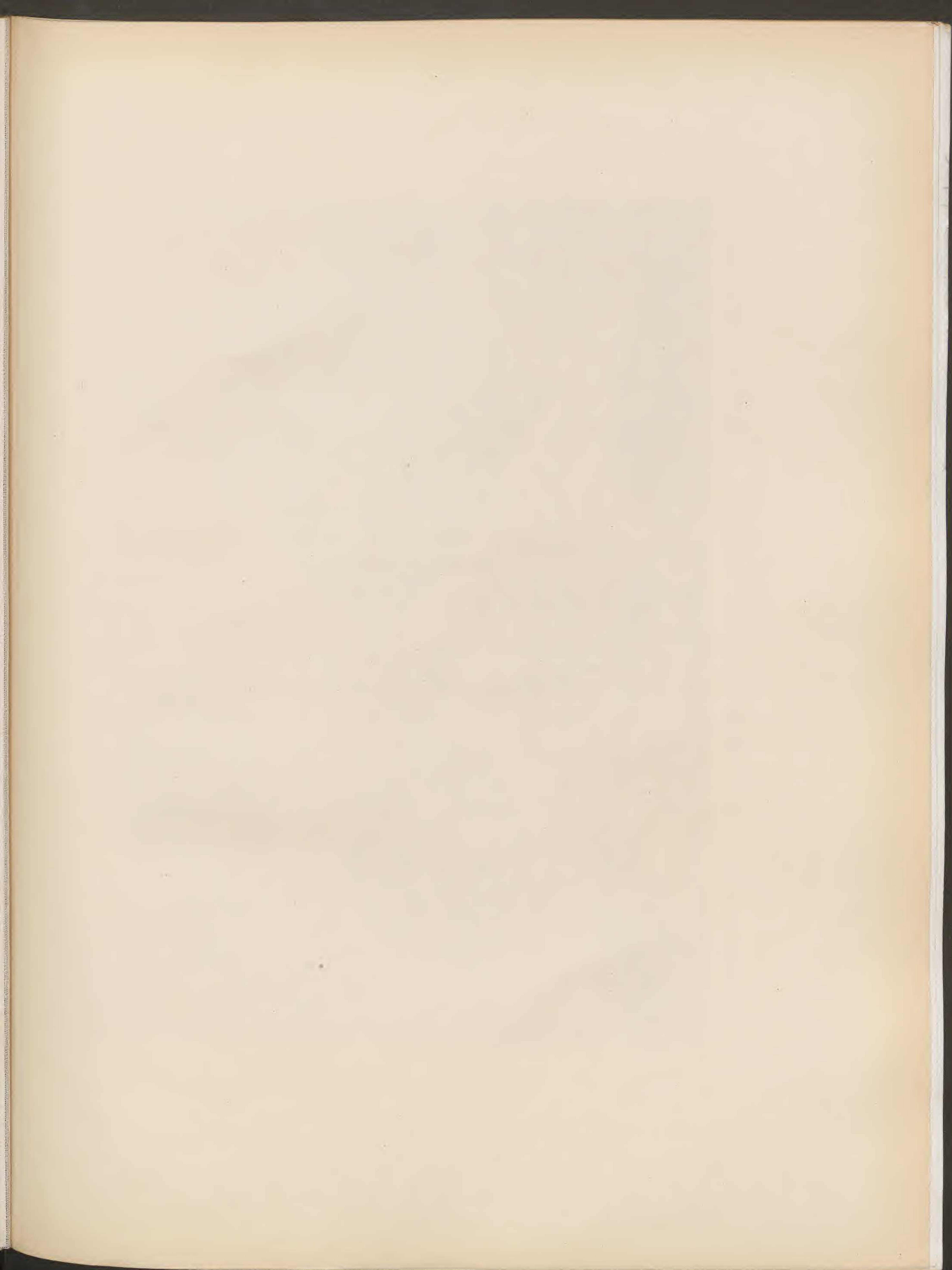
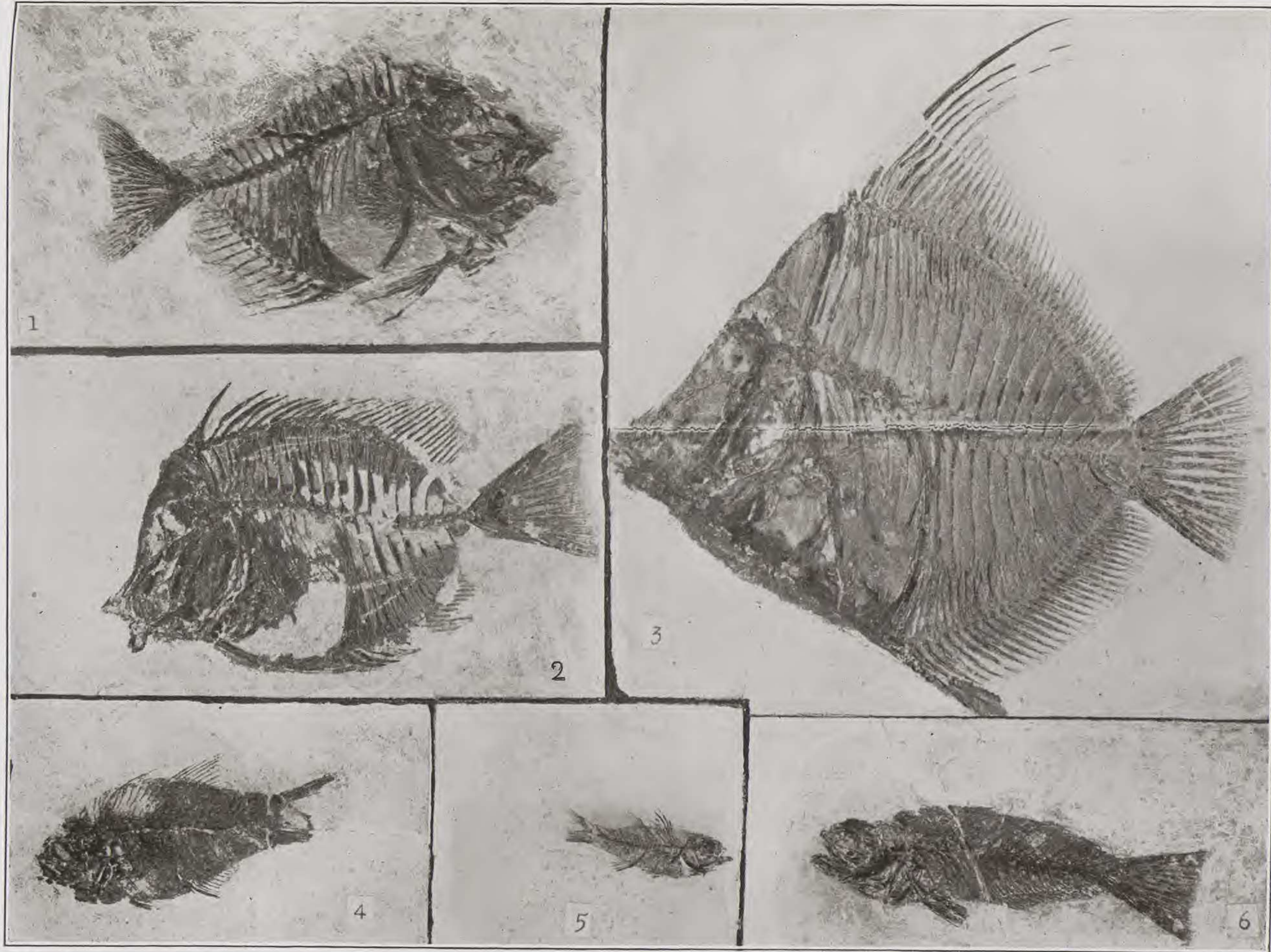


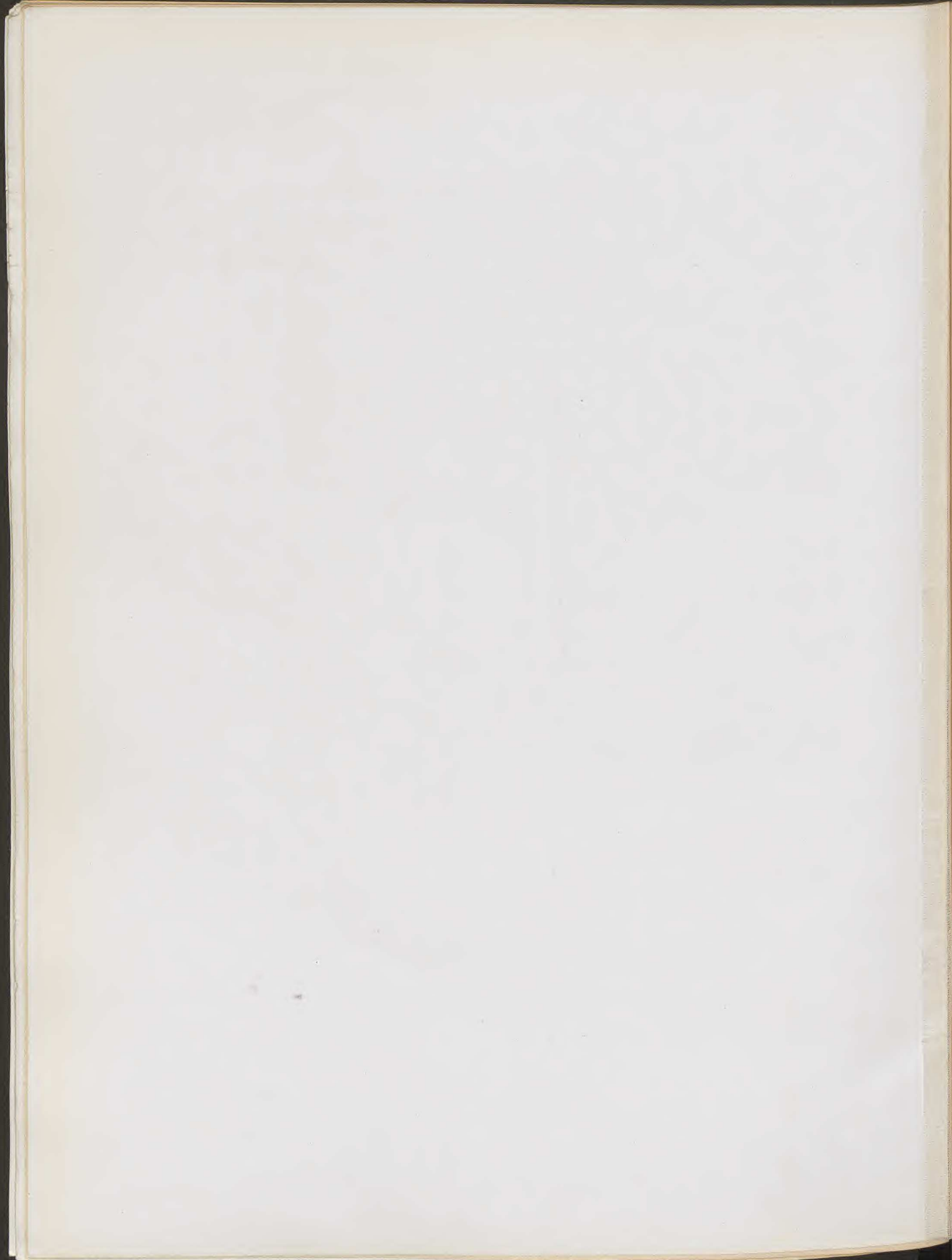
PLATE XCVII.

(All figures natural size.)

- Fig. 1. *Odonteus sparoides* Agassiz. C. M. Cat. No. 4208.
Fig. 2. *Naseus reclifrons* Agassiz. C. M. Cat. No. 4441a.
Fig. 3. *Zanclus brevirostris* Agassiz. C. M. Cat. No. 4415.
Fig. 4. *Cyclopoma micracanthum* (Agassiz). C. M. Cat. No. 4228.
Fig. 5. *Cyclopoma pygmæum* (Agassiz). C. M. Cat. No. 4212.
Fig. 6. *Seriola (Lichia) prisca* (Agassiz), juv. C. M. Cat. No. 4230.



1. *Odonteus sparoides* AGASSIZ. 2. *Naseus rectifrons* AGASSIZ. 3. *Zanclus brevirostris* AGASSIZ. 4. *Cyclopoma micracanthum* (AGASSIZ).
5. *C. pygmaeum* (AGASSIZ). 6. *Seriola (Lichia) prisca* (AGASSIZ) JUV.
(All figures natural size.)



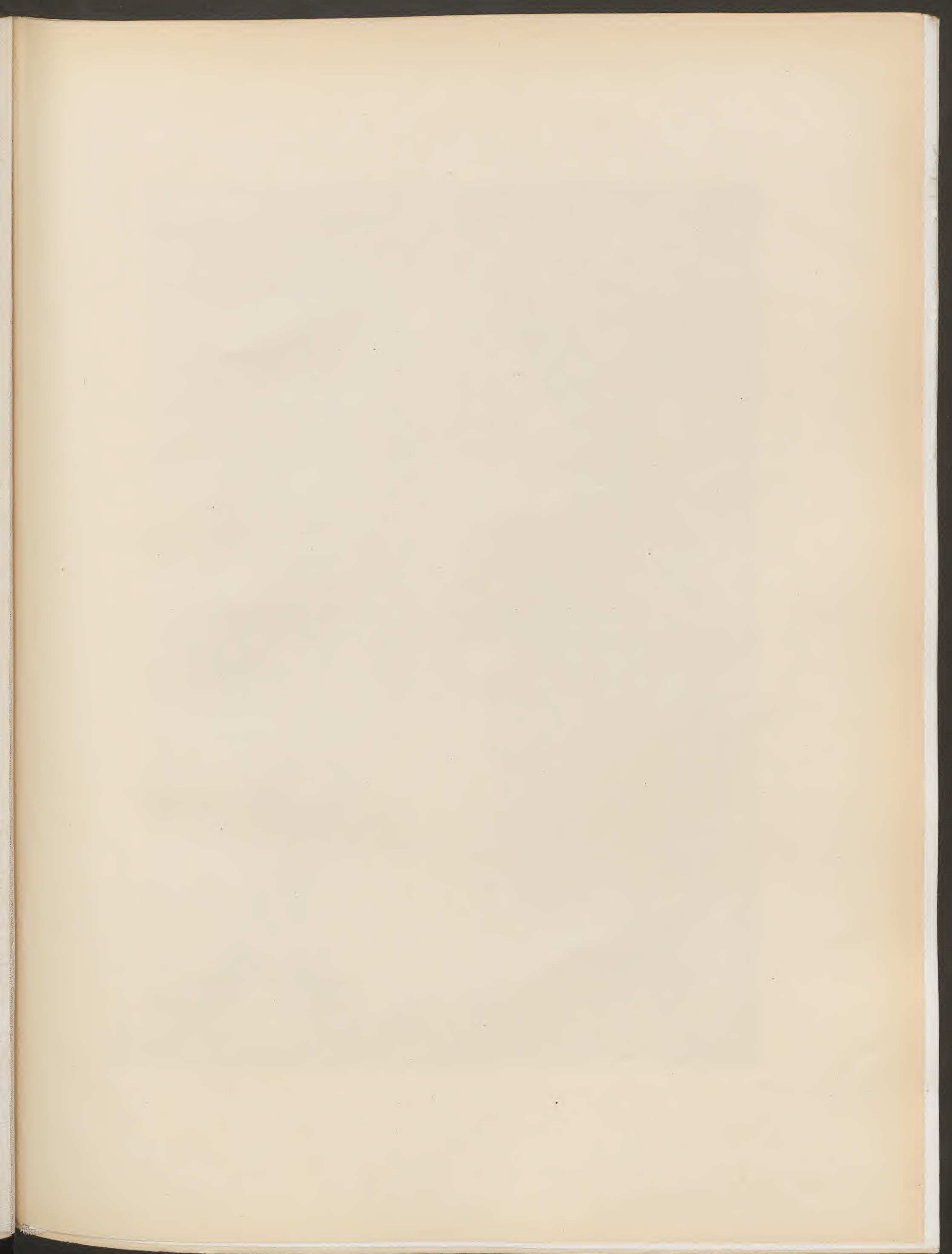
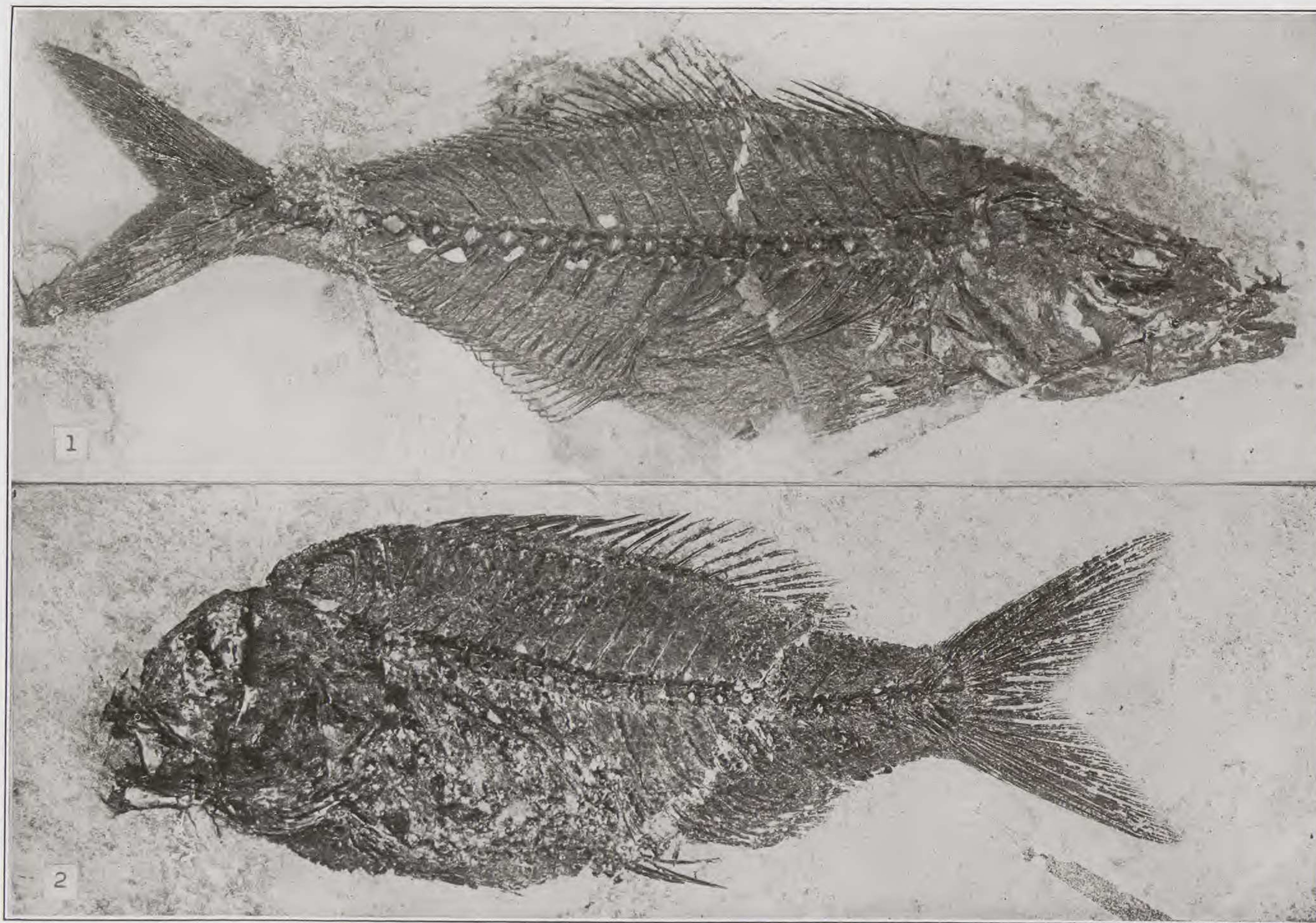
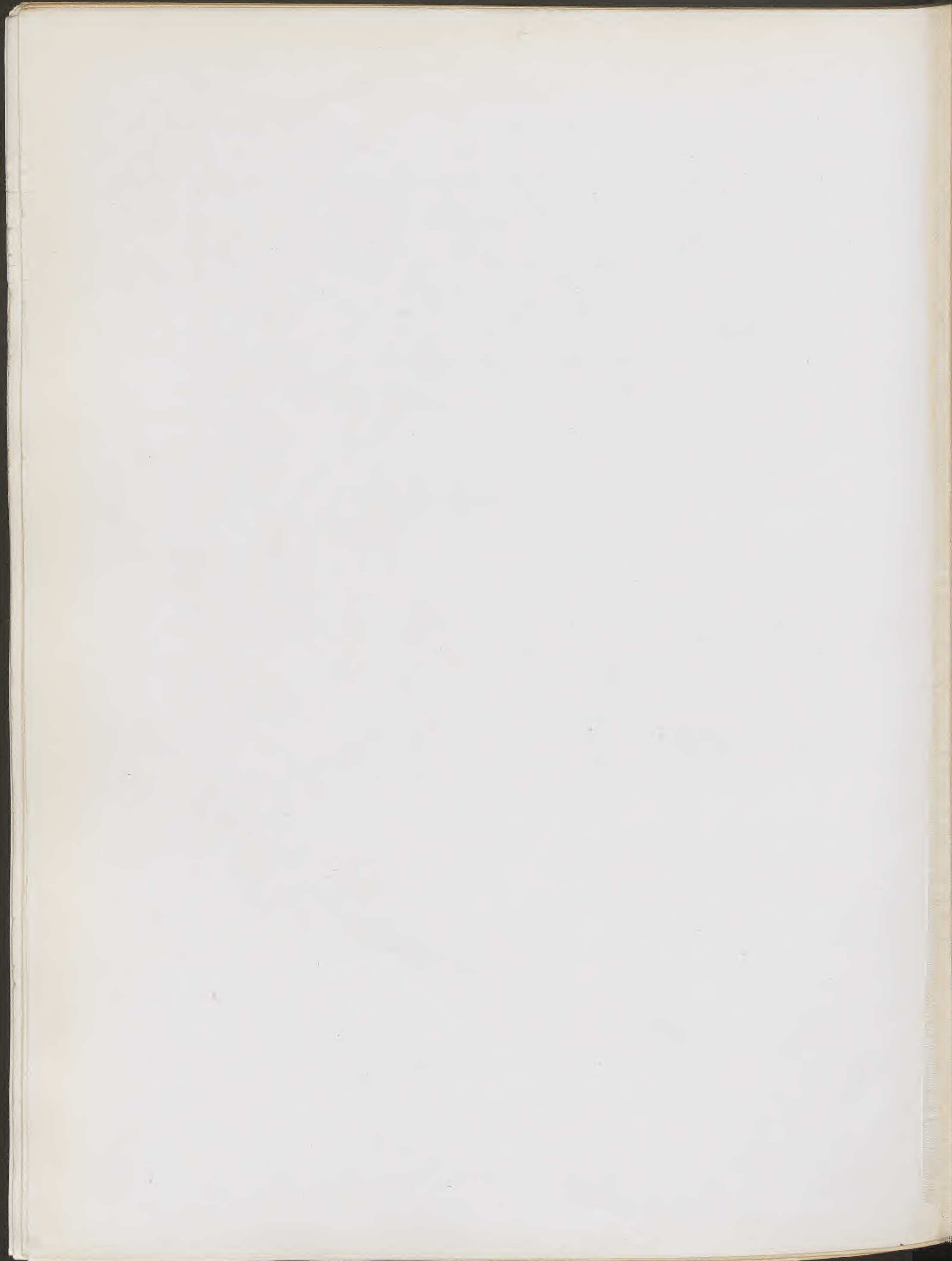


PLATE XCVIII.

- Fig. 1. *Seriola (Lichia) prisca* (Agassiz). Car. Mus. Cat. No. 4298. $\times 1/1$.
Fig. 2. *Sparnodus elongatus* Agassiz. Car. Mus. Cat. No. 4416. $1/1$.



1. *Seriola (Lichia) prisca* (AGASSIZ). $\times \frac{1}{1}$. 2. *Sparnodus elongatus* AGASSIZ. $\times \frac{1}{1}$.



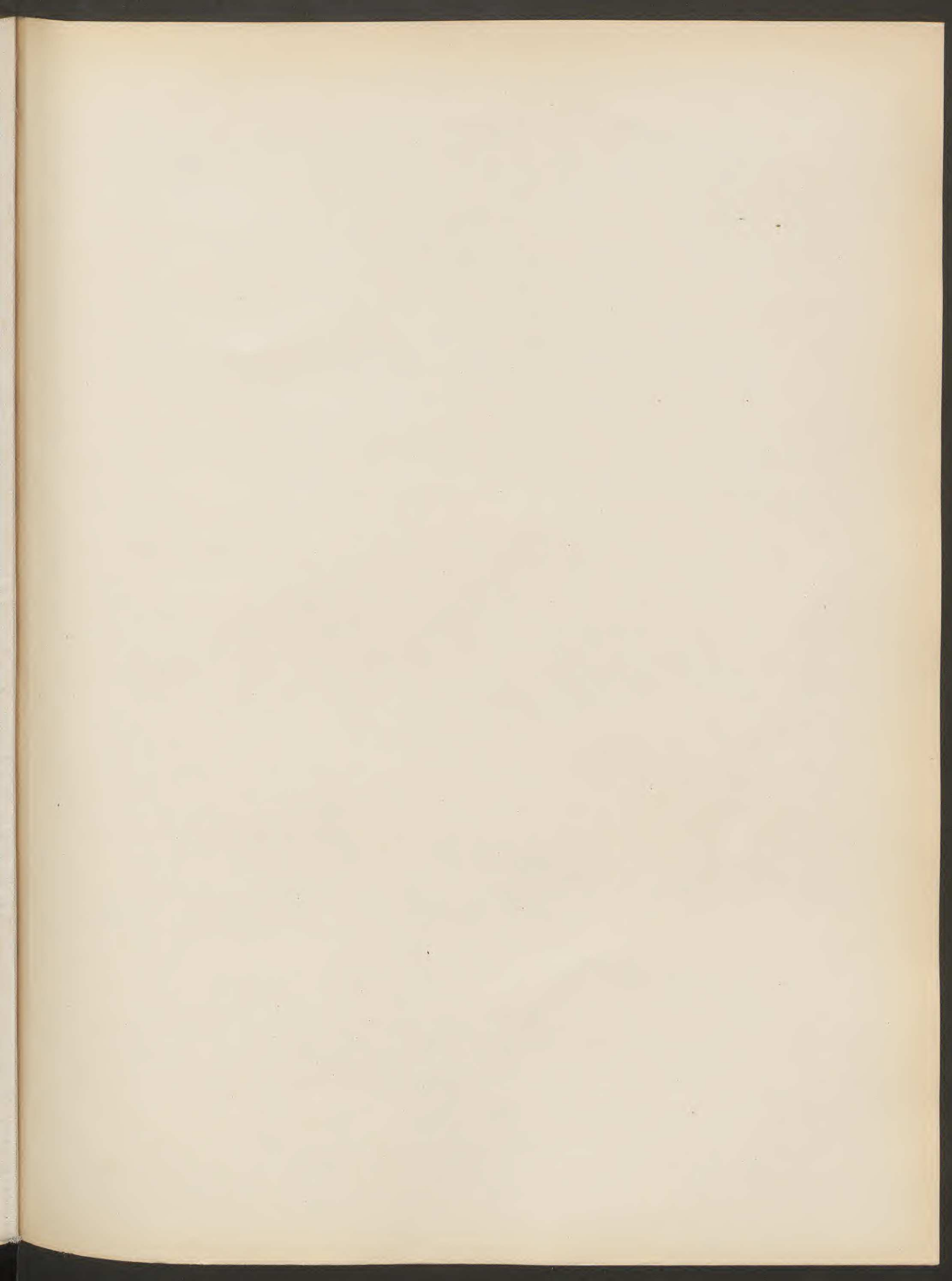
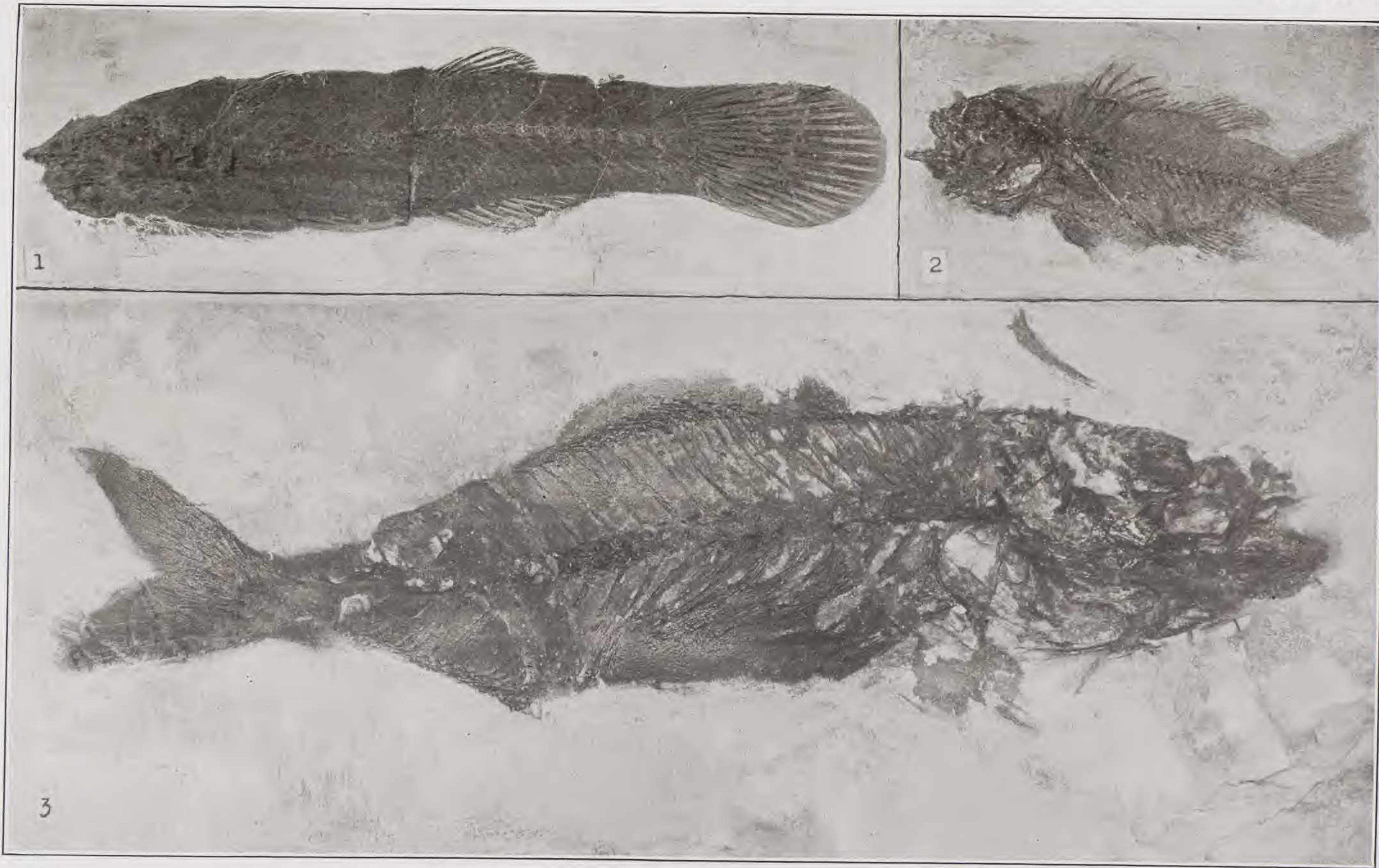


PLATE XCIX.

- Fig. 1. *Eocottus veronensis* (Volta). Figure inverted. Car. Mus. Cat. No. 4439. $\times 1/1$.
Fig. 2. *Lates gracilis* Agassiz, juv. Car. Mus. Cat. No. 4501. $\times 1/1$.
Fig. 3. *Seriola (Lichia) prisca* (Agassiz). Median fin-rays recumbent. Car. Mus. Cat.
No. 4545. $\times 4/9$.



1. *Eocottus veronensis* (VOLTA), figure inverted. $\times \frac{1}{4}$. 2. *Lates gracilis* AGASSIZ, juv. $\times \frac{1}{4}$. 3. *Seriola* (*Lichia*) *prisea* AGASSIZ. Slightly reduced.

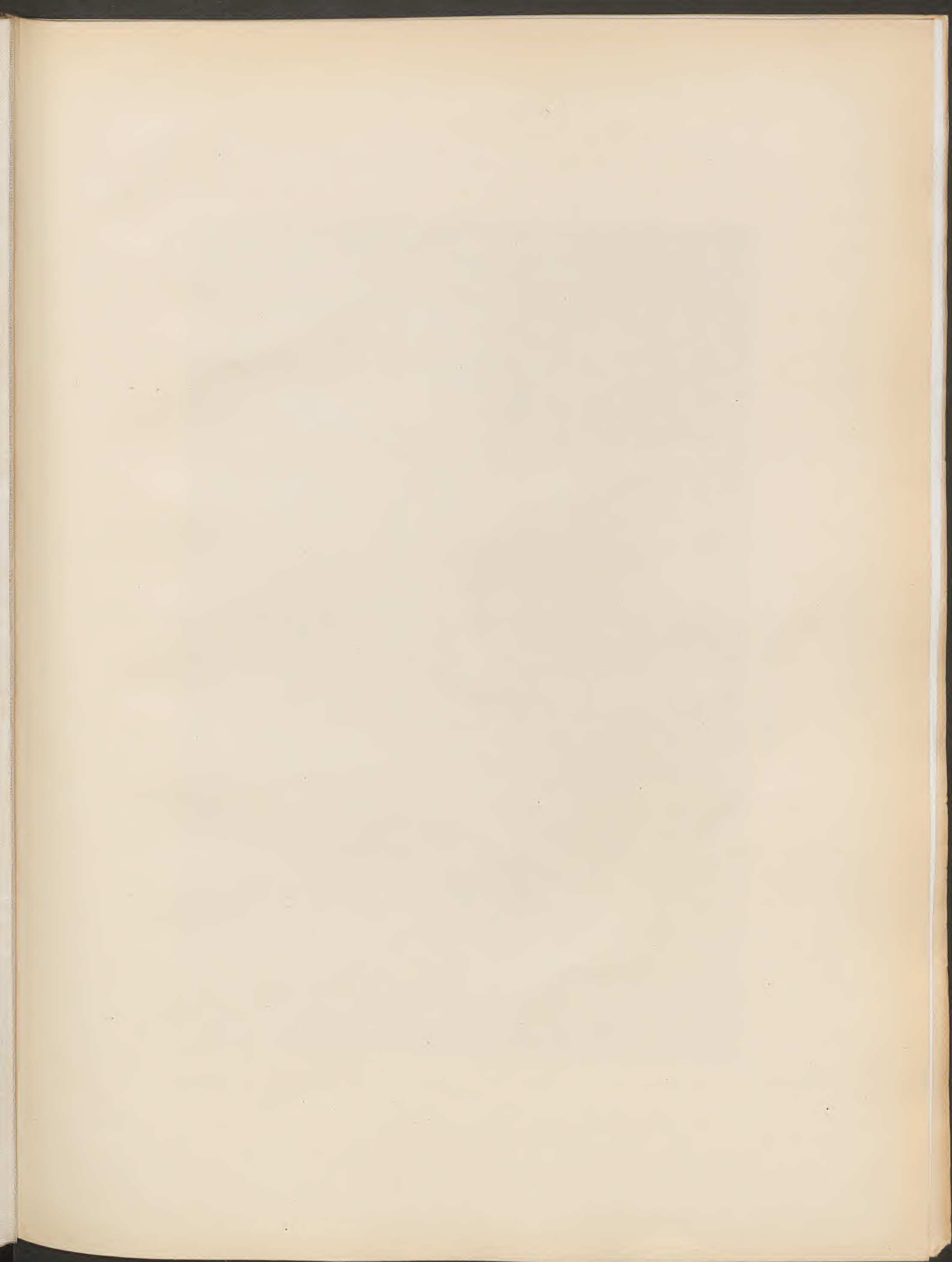
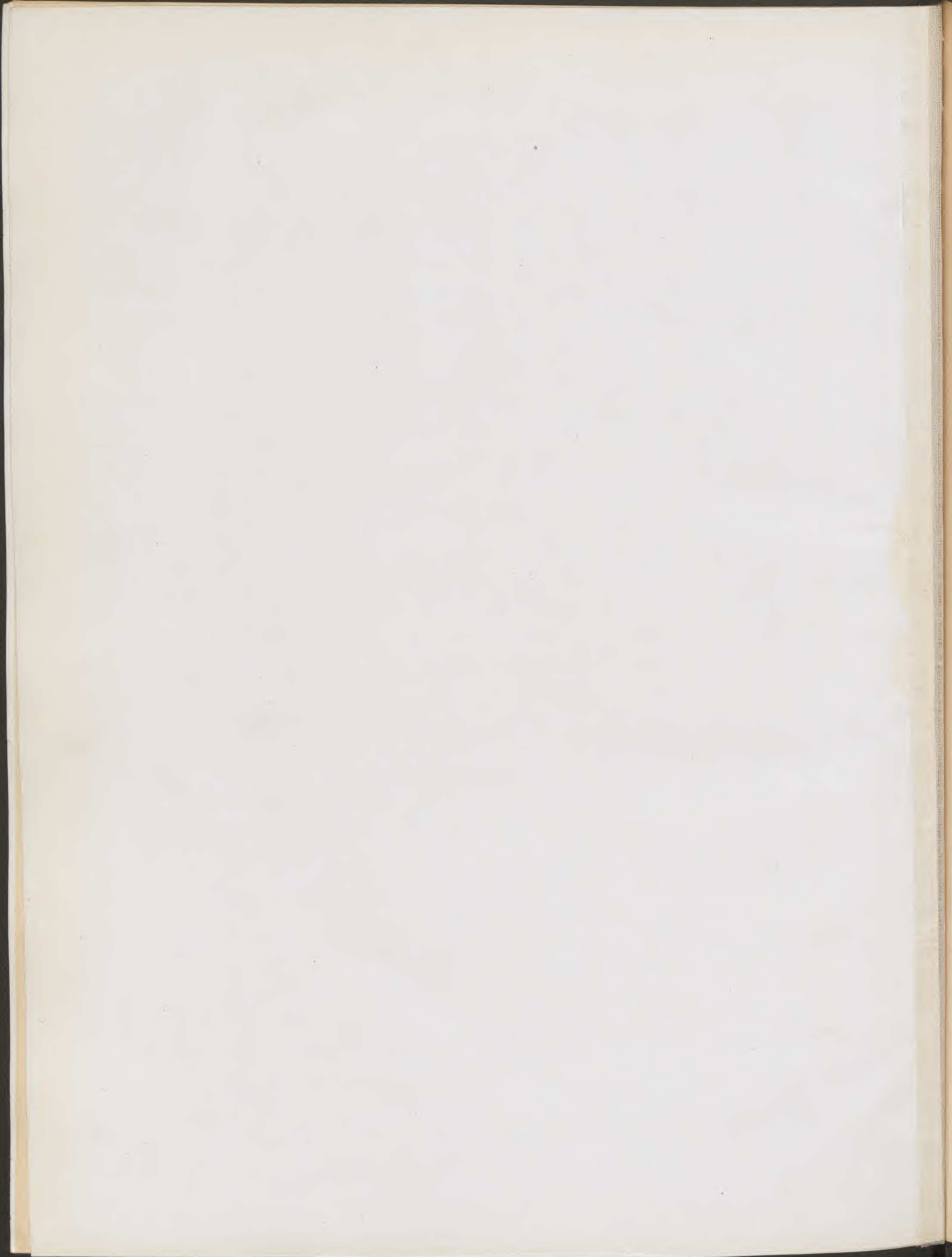


PLATE C.

Trachynotus cf. tenuiceps Agassiz. A deep-bodied form, perhaps of a distinct species. Car. Mus. Cat. No. 4414. $\times 1/1$.



Trachynotus tenuiceps (?) AGASSIZ. $\times \frac{1}{2}$.



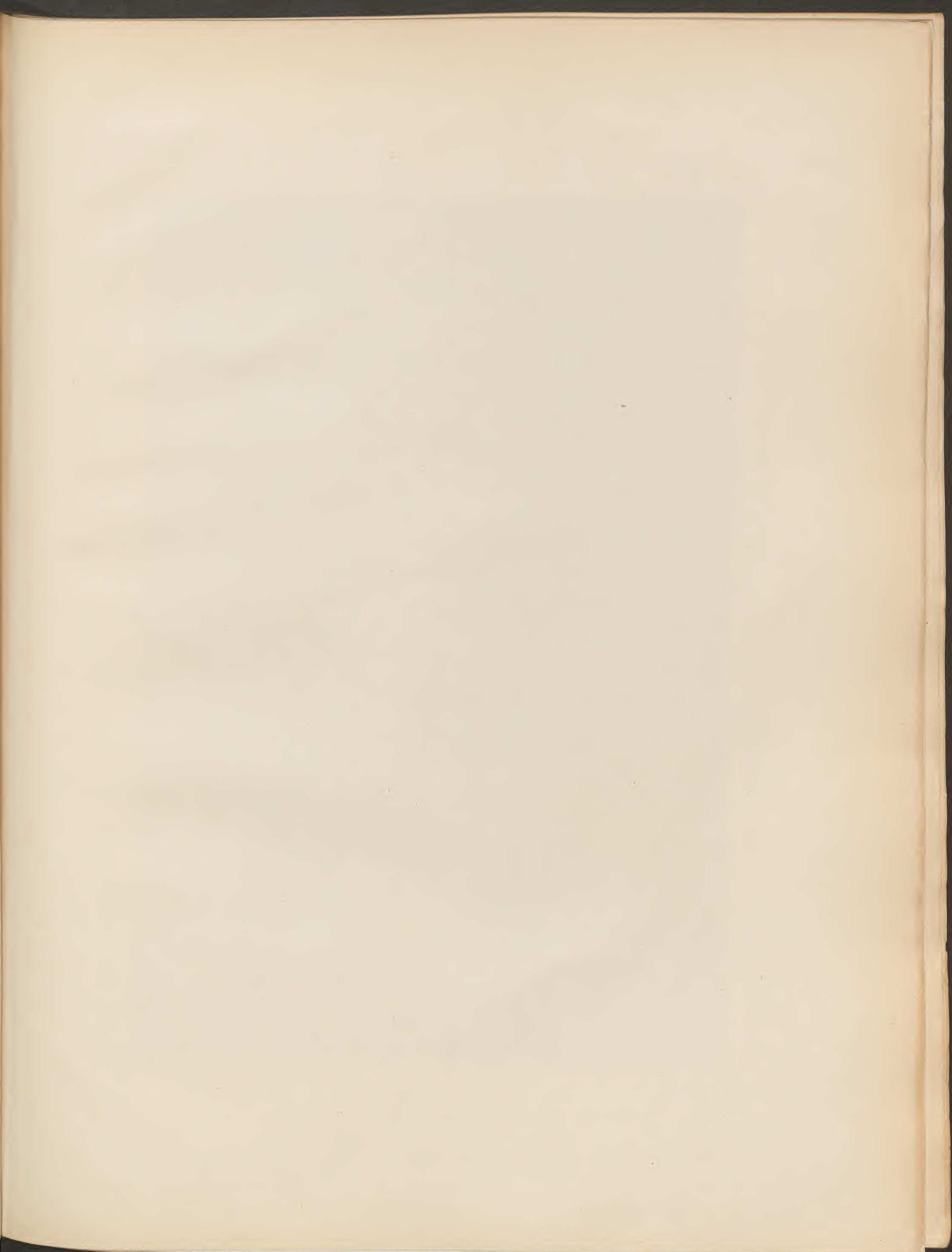
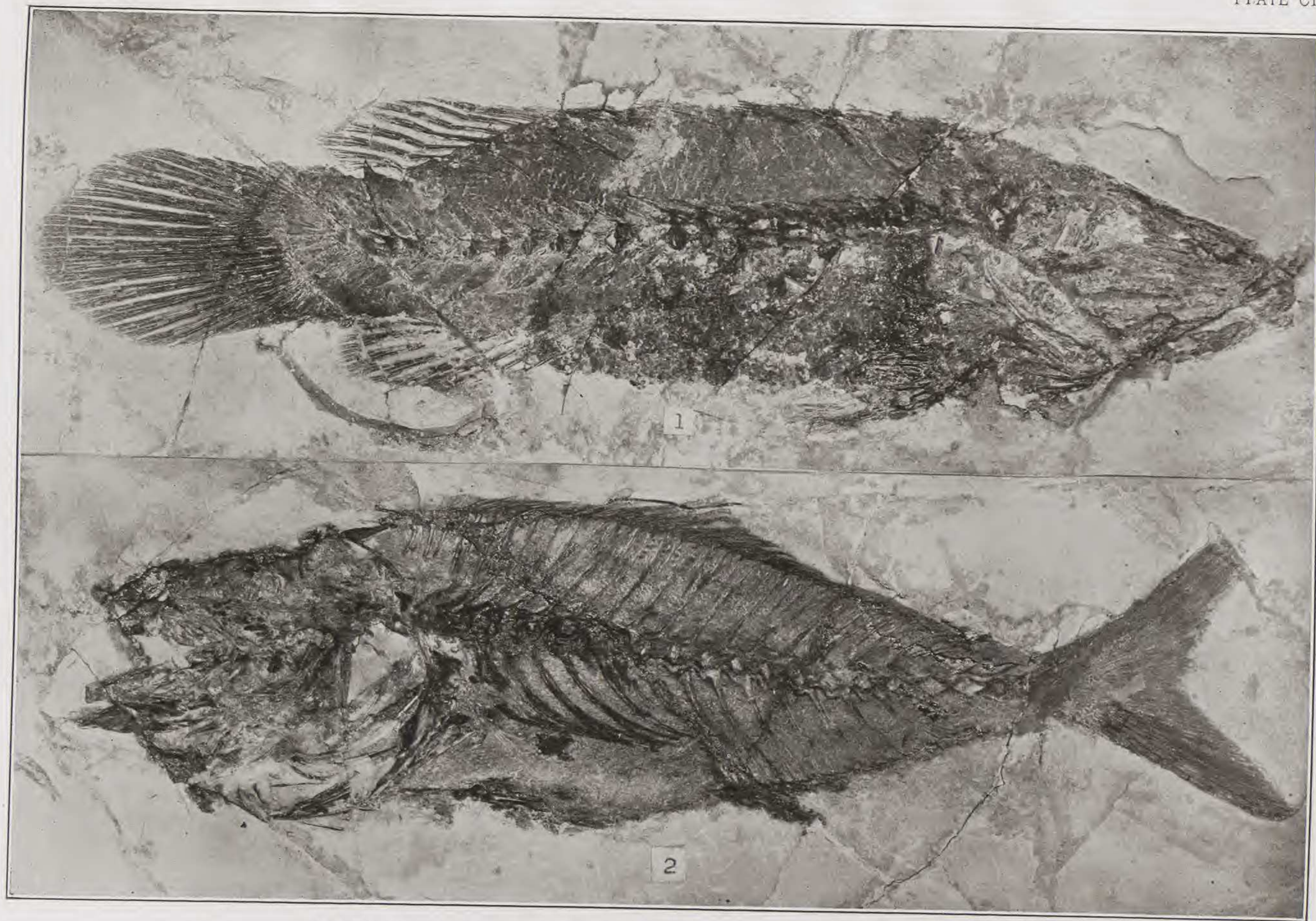
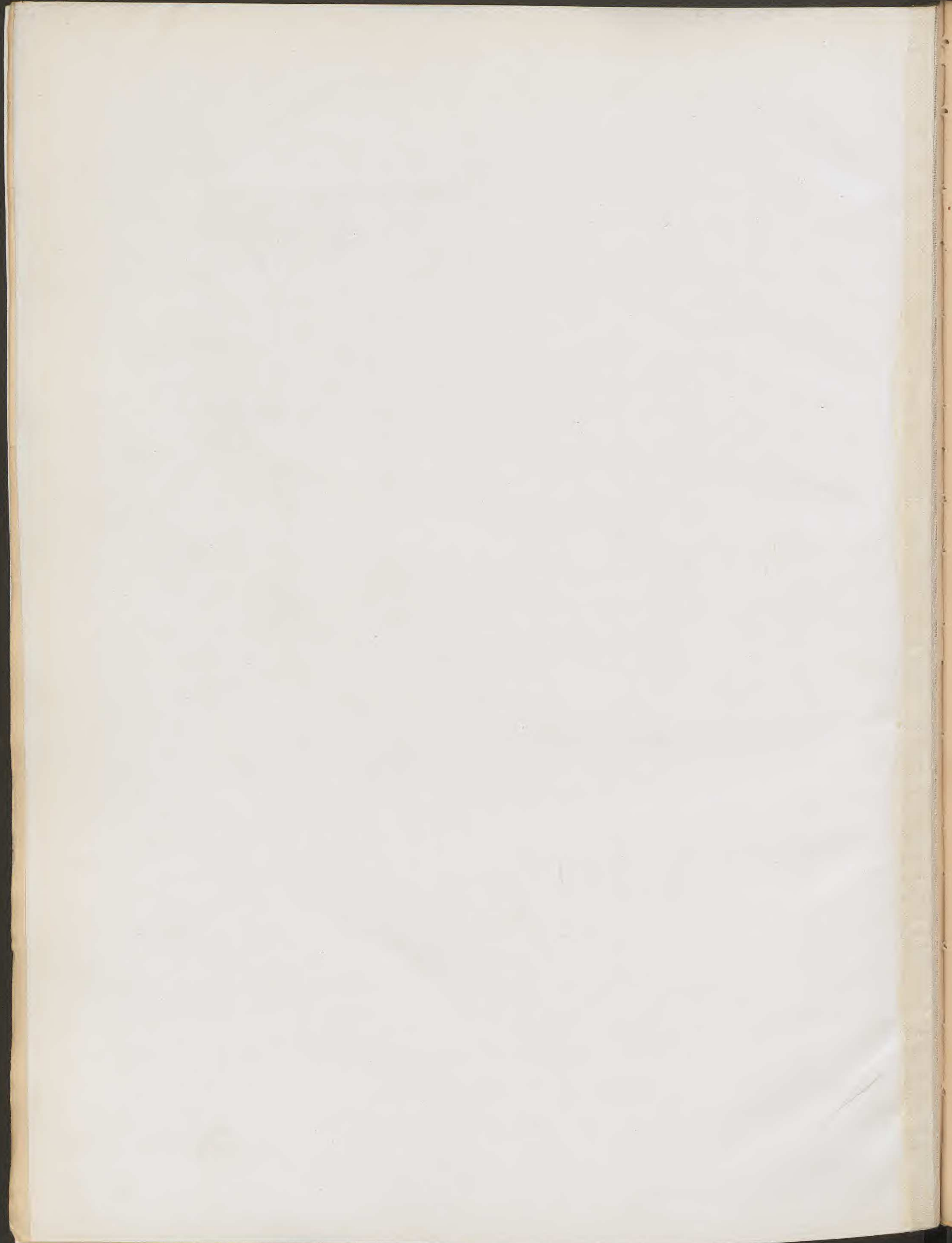


PLATE CI.

- Fig. 1. *Callipteryx speciosus* Agassiz. Car. Mus. Cat. No. 4404. $\times 3/7$.
Fig. 2. *Seriola (Lichia) prisca* (Agassiz). Median fins recumbent. Car. Mus. Cat. No.
4469a. $\times 1/2$.



1. *Callipteryx speciosus* AGASSIZ. $\times \frac{1}{2}$. 2. *Seriola (Lichia) prisca* AGASSIZ. $\times \frac{1}{2}$.



INDEX.

- abacopus Glossogobius, 159, 200
 abbreviatum, Xystæma, 190
 Abudefduf saxatilis, 194
 sordidus, 194
 Acanthocephala mesoprion, 204
 Acanthonemus, 391
 filamentosus, 370
 subaureus, 370, 400
 Acanthopterygians, 385
 Acanthopterygii, 362, 390
 jugulares, 389
 Acanthuridæ, 390
 Acanthurus, 391
 triolestegus, 382
 Achænodon, 145, 146
 uintense, 145
 Acheilognathus mesembrinum, 170
 Acronuridæ, 381
 aculeatus, Centriscus, 362
 Rhamphosus, 362
 acuticeps, Parasalanx, 167
 Ælurocyon, 278
 Ælurodon, 260, 264, 278
 meandrinus, 263
 taxoides, 263
 æolus, Sillago, 192
 æquulæformis, Gazza, 181
 affinis, Caranx, 178
 africana, Viverra, 219
 Agassiz, Louis, 286, 357
 Agate Spring Fossil Quarries 41, 42, 61,
 66, 75-77, 86, 87, 112, 141, 206, 207, 262
 Agostini, Serafino, 143, 205
 akajei, Dasyatis, 164, 165
 Alasmidonta, 290, 299, 315, 324, 336
 calceola, 300
 heterodon, 287, 292, 300, 332, 346
 marginata, 292, 300, 301
 marginata varicosa, 292, 300, 301
 Alasmidonta triangulata, 300
 undulata, 292, 298, 300, 314, 315 346
 alata, Lampsilis, 287, 296, 299, 301, 302, 307
 alatunga, Scomber, 372
 albus, Monopterus, 171
 Aldrovandi, Ulysses, 352
 Alectis ciliaris, 180
 major, 180
 Alexandrinum molinii, 352
 alleteratus, Euthynnus, 177
 Alopias vulpes, 162
 Alopiidæ, 162
 Aloiopsis cuvieri, 353
 plejodon, 352
 Alston, Edward Richard, 43
 altalunga, Scomber, 372
 altigenis, Temnocyon, 213
 altivelis, Plecoglossus, 167
 Sparnodus, 378
 Amba koyo, 178
 ambigua, Hemilastena, 300, 301
 Amblygaster immaculatum, 166
 maculatum, 166
 Amblygobius phalæna, 201
 sphinx, 201
 amboinensis, Lethrinus, 189
 American Entelodonts, 87
 American Philosophical Society, Paper
 read before, 63
 americanus, Amphicyon, 260, 263
 Bison, 98, 143
 Ami, H. M., 149
 Amia elizabethæ, 181
 indica, 375
 quadrifasciata, 181
 Ammodon, 58, 67
 leidyanum, 58, 67, 68, 77, 148
 Ammodon, Known Generic Characters of,
 67

- Ammodytes tobianus*, 359
 Ammodytidae, 204
Amphicyon americanus, 260, 263
 crucians, 260
 giganteus, 211
 lemanensis, 260
 major, 212, 233, 242, 248
 sinapius, 263
 superbus, 207
 ursinus, 263
 Amphicyoninae, 207
 Amphistiidae, 382
Amphistium paradoxum, 382, 383
anagoides, *Leptocephalus*, 171
anago, *Leptocephalus* (*Congrellus*), 171
analis, *Carangopsis*, 368
 Lichia, 368
 Seriola, 368
Anampses caeruleopunctatus, 195
 Anaplotheriidae, 145
anceps, *Canis*, 215
Anchovia hamiltoni, 166
 indica, 167
 koreana, 167
 Ancient Chinese inscriptions, 5
 Fauna of Nebraska 47
 Inscriptions upon Bone and Tortoise-shell, 30-35
 sign-makers of China, 16
Ang hii, 185
 ke, 189
 tsoh, 184
 Anglo-Chinese Dictionary, 16
Anguilla, 391
 latispina, 358
 manilensis, 171
 mauritiana, 171
 remifera, 171
 sinensis, 171
 ventralis, 357
anguillaris, *Plotosus*, 168
anguillicaudatus, *Misgurnus*, 169
 Anguillidae, 171
 Annales de la Société d'Agriculture, des Sciences, et de Commerce du Puy, 43
annectens, *Nothocyon*, 206
 annularis, *Lutianus*, 184
Anodonta, 282, 287, 290, 299, 315, 324, 332, 337
 cataracta, 292, 313, 314
 ferussaciana, 300
 fluviatilis (= *cataracta*), 305
 grandis, 292, 300, 313
 grandis gigantea, 288, 289, 311, 341, 345
 henryana, 310
 imbecillis, 292, 300, 307-310, 313, 314, 346
 ovata, 300
Anodonta, *Glochidium*, 323
 -group, 293, 296, 324
 -structure, 304
Anodontinae, 328, 332, 336
Anodontites, 337
 crispata, 337
Anodontoides, 287, 290, 292, 299, 315, 324, 332, 337
 ferussacianus, 292, 300, 306, 313, 314, 346
anomala, *Psenopsis*, 181
Anoplus banjos, 188
 Antennariidae, 389
Antennarius, 389, 390
 marmoratus, 389
 Anthracotheriidae, 145
apoda, *Coryphena*, 355
Apodes, 357
apodus, *Pycnodus*, 355
Apogon macropterus, 182
 notatus, 181
Apogonichthyidae, 181
Apogonichthys fo, 181
Apolectus niger, 179
Archæotherium, 44, 47, 61, 64, 66, 79-84, 92, 93-99, 104-107, 110-121, 124, 130-141, 144, 147, 153
 clavum, 50, 148
 coarctatum, 49, 52
 crassum, 50-53
 ingens, 53, 61, 62, 87, 91, 93-97, 99, 104-107, 111, 114, 121, 122, 126-129, 133, 138, 143
 mortoni, 47-50, 87, 151

- Archæotherium robustum, 151
 Archæotherium, Principal Generic Characters, 47
 Archamia bleekeri, 182
 fucata, 182
 lineolata, 182
 macropteroides, 181, 182
 macropterus, 182
 notata, 181
 aretatum, Elotherium, 55
 Aretitis, 239
 Aretodon, 47, 153
 of Leidy, 145
 argentata, Corvula, 191
 argentimaculatus, Lutianus, 184
 argus, Chætodon, 381
 Scatophagus, 197
 argyrophanes, Saurida, 168
 Argyrops longifilis, 189
 armatus, Carangus, 39
 Caranx, 179
 Artiodactyla, 96, 148
 asotus, Parasilurus, 168
 asper, Chætodon, 380
 Atherina bleekeri, 176
 Atherinidæ, 176, 359
 Atherinoides, 359
 Atkinson, D. A., 310
 Atkinson, William Sackston, 159
 Aulostoma, 360, 361
 chinensis, 361
 Aulostomatoidei, 360
 auratus, Carassius, 169
 aureus, Chætodon, 370
 auriculatus, Carcharodon, 352
 auritus, Scarichthys, 196
 Auxis, 391
 propterygia, 373, 374
 awoara, Epinephelus, 183
 Aymard, A., 41, 43, 45, 46, 144, 149
 azurio, Choironodon, 194

 Baker, F. C., 338
 Ba lang, 178
 banjos, Anoplus, 188
 barbata, Candidia, 169
 barbatum, Ophidium, 358
 barbatus, Gobius, 385
 Opsariichthys, 169
 Barbour, Professor E. H., 71, 73, 87
 barbatus, Hemibarbus, 169
 Bassani, Francesco, 351
 bassani, Histioccephalus, 390
 Histionotophorus, 390
 bathrodon, Elotherium, 58
 Pelonax, 57-60
 Batrachidæ, 389
 Bayet, Baron Ernst de, 349
 Bayet Collection, 249, 357, 365, 368, 369,
 373, 376, 380, 381, 386
 Belonidæ, 175
 Beng pian, 167
 bennetti, Dasyatis, 164
 bensasi, Upeneoides, 193
 berda, Sparus, 189
 Berycidæ, 362, 363
 Beryciformes, 363
 Berycoid fishes, 362, 363
 Berycomorphi, 363
 Beryx, 363
 Bibliography: Entelodontidæ, 149-156
 Bibliography: Najades, 338-339
 bifasciatus, Labrus, 374
 bilineata, Paraplagusia, 202
 Bin hii, 201
 bipunctatus, Hepatus, 198
 Bison americanus, 98, 143
 bleekeri, Archamia, 182
 Atherina, 176
 Blennidæ, 203, 386, 388
 Blenniiformes, 386
 Blennius, 388
 Blochiidæ, 386
 Blochius, 391
 longirostris, 386, 387, 388, 392
 macropterus, 386
 moorheadi, 387
 bolcensis, Platyrhina, 351
 Sphyræna, 359, 360
 Thynnus, 373
 Boöchoerus, 61, 119, 129, 130, 151, 153,
 155, 156